THE

ELECTRICAL REVIEW.

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THE TELEPHONE DEBATE.

THE most satisfactory result of the Parliamentary debate on telephones on Friday night last was the recognition of the fact that an agreement is an agreement.

We place that first because it is general and of more importance than anything which pertains to a particular subject. But on the particular subject of debate much satisfaction may be found from Mr. Arnold Morley's speech. The appointment of a Select Committee "to consider and report whether the provision now made for the telephone service in local areas be adequate, and whether it is expedient to supplement or improve that provision by the granting of licenses to local authorities or otherwise" resulted from an amendment by Mr. Morley, and included the substance of Mr. Benn's motion when the consideration of the agreement was struck out. It was apparently useless for Mr. Benn to press his motion to a division when the leaders of the opposition and the Government took up an identical position so far as the agreement was concerned.

There was a clear issue between the front benches and the private members on this point. Mr. Benn "was very anxious the House should regard the heads of arrangement as merely a provisional document." Captain Bagot urged "that the present draft agreement seemed to go beyond the Treasury minute" in which view he was supported by Sir J. M. Carmichael and Mr. Provand, the last mentioned objecting to the inclusion in the agreement of a charge "for what were called terminals." Attention was also drawn to the fact that competition was contemplated by the Treasury minute and abolished by the agreement. Mr. Labouchere urged that when the Select Committee stated that the agreement was to be laid on the table they meant that it was to be submitted to the judgment of the House. Mr. Arnold Morley said that he had asked the opinion of the members of the committee, and had been told by all that they intended no more than that Parliament should be informed of the result of the negotiations. The view taken by the Government was that there was a contract entered into between the late Government and the Telephone Companies from which they could not honourably withdraw, and therefore they would not consent to the agreement being referred to a Committee. In this view the Postmaster-General was supported by Sir J. Gorst, Mr. Goschen, and the Chancellor of the Exchequer, who said "it would be a most serious thing if the House of Commons repudiated an agreement which had been made by the Executive Government."

Mr. Benn made a great feature of the fact that the words "and send for persons, papers, and records" were omitted from the reference to the Committee on the Telegraph Bill, and yet in our copy of the Report of this Committee, which is "printed for Her Majesty's Stationery Office," we find it "*Ordered* that the Committee have power

to send for Persons, Papers, and Records." Mr. Provand's objection that the agreement went beyond the Treasury Minute, because it included terminal charges, would hardly be regarded as serious criticism even if it were correct. We doubt very much whether Mr. Provand, as a commercial man, would undertake to do work for somebody else without remuneration. But Mr. Provand is not correct in saying that in this respect the agreement goes beyond the Treasury Minute. The principal reference to charges in the Minute is in Clause 14 relating to conversations over trunk wires, and to this clause there is a note intimating that "These charges are independent of the charges which the companies make on their own account for sending a telephone message." Members were, however, on safer ground in maintaining that the Treasury Minute contemplated competition, whilst the agreements did not, and we regret that some further light was not thrown on this point.

There was an inference at least that competition was expected to be continued between the companies which existed, but in the absence of any restriction on the amalgamation of those companies, it was perfectly obvious that the Treasury minute would lead to the absorption of one company by the other. We called attention to this at the time, but we were not prepared for the footnote to one of the clauses of the agreement, which provided that if the National and New Companies simultaneously accepted the agreement, the general prohibition to amalgamation might be struck out. Mr. Benn spoke of secretly buying up the opposition company, and alluded to it as an endeavour to get behind a committee of the House which disentitled the company to any consideration at the hands of the House. Something more should have been said on this point. The buying up was not secret. It was obviously contemplated by the Post Office. We do not question the ultimate advantage, but we believe that it will be almost impossible to get the public to understand that in the avoidance of competition, there was any advantage at all, and we most decidedly object to the value which was given to the New Telephone Company's license by the Treasury minute, and to the profit which the promoters of the company were enabled to realise thereby.

We feel that we are on more satisfactory ground when dealing with Mr. Arnold Morley's speech. To appreciate it fully, we must remember that he is a member of a Liberal Government, whose objections to monopolies are strong, and whose encouragement of the extension of local government is generally recognised. Mr. Morley held that in all matters proper to them, municipalities did their work much more effectively than the central government could; but there was a great distinction between telephones and gas and water. The telephone system was in no sense a local requirement; it was no more local in its attributes than either the post or the telegraph. Herein we see evidence that Mr. Morley has studied the question and grasped its main features, and therefore we have some hope that the solution may be satisfactory, although just at present the position of affairs is peculiar, and certainly will not commend itself to public opinion as generally formed.

It is perfectly true that the agreement grants no monopoly; the powers of the post-office to license others or to compete themselves are ample. The power of prospective competition there is, actual competition there is none. Public opinion says, How is the Telephone Company to be brought to reason except by actual competition? Mr. Morley in effect replies: The only monopoly is the monopoly of the State, and it is the duty of the State to provide a reasonably efficient and a reasonably cheap service either through itself or its licensees. Therefore, if a case were made out in any locality that the service was not reasonably efficient or reasonably cheap it would be the duty of the Government to secure that such an efficient and reasonable service was provided.

Mr. Morley has a difficult task, but we believe that he understands the position, and we have some faith in his being able to carry it through. He desires to retain the State control of telephones, he desires to avoid the inconveniences of competition in one area, and yet he desires that the service should be good and the charges reasonable. Many will doubt whether these advantages can be secured by the mere existence of the power to compete. Very few will realise that there is any disadvantage in competition, and some will doubt the ability of the National Telephone Company to take a sufficiently broad view of its responsibilities. Our views of the Treasury minute and the agreement are on record, and we have little to add and nothing to alter. In the earliest stages we urged that any attitude other than free trade or Government purchase would be difficult to maintain. We shall see what conclusions the new committee will reach. They have to decide not matters of fact, but matters of opinion. It will be extremely difficult to adopt a standard for comparison, or make suggestions which shall comply with the necessary protection of public interests and private rights. We hope that they will attach due weight to Mr. Morley's views, and as far as possible leave the decision to the executive officers. Sir J. Carmichael's opinion that business men always get the best of any bargaining with permanent officials is not borne out by the agreement, at any rate, as will be seen by the review of it in our issue of August 24th, 1894. We believe there is more danger from Municipal interference on any other than purely local Government questions than from the Post Office management of all negotiations. They have to be undertaken with a view not merely to present requirements, but also to future conditions of great importance.

One great danger—which must be as apparent to the official as to the private member—is the enhancement of the value of the company's property for which the State may eventually have to pay. The best way to come safely out of any negotiations having that view in mind, is to act with fairness and with knowledge. The prevailing characteristics of attacks on "the telephonic monopoly," so far as we can see, are unfairness and lack of knowledge. Hence, generally, their non-success, and hence our advice to leave the matter to Mr. Morley and the Post Office.

THE CAUSE OF THE ST. PANCRAS EXPLOSIONS.

So eminently respectable and austere a body as the Board of Trade can hardly be accused of indulging in a little cheap, if mild sensation; and the scientific attainments which are no doubt possessed by its permanent officials should place it beyond suspicion that, in the cause recently assigned to

account for the St. Pancras explosions, they have not "discovered a mare's nest." It is open to us to hark back to the days when we read Horace, and to remember that pathetic line, *Aliquando bonus dormitat Homerus* ("Sometimes even the good Homer nods," as Pope puts it); or, to assume an uncompromisingly sceptical attitude towards this latest deliverance of our respected Board of Trade; but neither of these alternatives exactly provides us with the standpoint which we deem it advisable to take up. We must, therefore, cast about us.

Let us see, first of all, whether we can throw in our lot with the Board of Trade. In Sir Courtenay Boyle's letter to the Electric Lighting Committee of the St. Pancras Vestry, he states that their electrical adviser (Major Cardew) "has discovered in his investigations into the recent explosions in the street boxes used for electrical supply in St. Pancras, that a remarkable deposit on some of the insulators contained a considerable quantity of the metal sodium. The presence of this metal, which is highly inflammable by contact with water, appears to be" a "grave source of danger, and to afford" a "reasonable explanation in connection with the accumulations of escaped coal gas, of the several explosions which have recently occurred." Consequently the Board urges upon the Committee the advisability of immediately taking three precautions, two of which are designed to eliminate the coal gas, and the third to clear out this "remarkable deposit."

From this it appears that the *deus ex machinâ* which is called up to account for these baffling catastrophes, is the metal sodium. Now what does the Board of Trade know of the properties of this metal? Very little, it would seem, judging from Sir Courtenay Boyle's letter. Granting for the sake of argument, the statement that metallic sodium *is* formed in the conduits and street boxes (we will not ask the Board to explain how), what is likely to happen to it? Does the Board of Trade know that as soon as a *particle* of metallic sodium finds itself in a damp atmosphere, such as may reasonably be assumed to exist in the conduits, &c., under consideration, it commences to cease to be sodium, and that with great rapidity? Is it not because it cannot be kept in the presence of moisture, such as exists in the driest of air, that we are accustomed to store it under rock oil that has been carefully dehydrated? And then, who taught the Board of Trade that sodium is "highly inflammable by contact with water"? Is it so far oblivious of its schooldays as to be forgetful of the fact that when sodium is brought into contact with water, hydrogen is given off, and caustic soda formed, without any flame appearing at all? True, under certain artificial conditions, the escaping hydrogen will inflame, but not the metal sodium. Perhaps the Board of Trade retains a hazy recollection of the behaviour of potassium under similar conditions; or, perhaps, it is dealing with a substance hitherto unknown to chemists, and which it can't help blundering about, because it has not completely investigated it.

Turning, now, from the unscientific dicta of the Board of Trade's recommendation to their apologists, we cannot but notice the animadversions of our esteemed contemporary, the *Electrician*. In its issue for March 1st, it is at pains to explain how the presence of the metal sodium is to be accounted for. Our contemporary asks us to believe that the stoneware insulators are actually electrolysed in some obscure way (not defined), and that the metal sodium is thereby produced. We presume it really means that the glaze on the insulators, which consists chiefly of sodium silicate, is electrolysed: for otherwise, knowing the composition of stoneware, we cannot entertain the view seriously.

In thus helping our contemporary out of the pitfall into which they have doubtless accidentally stumbled, we should like to ask them whether they are aware that the silicates are amongst the most refractory, stable, and difficult-to-decompose substances known to chemists, and that, in consequence of this, stoneware finds most unique and useful applications in all the acid and alkali industries?

For our own part we should immensely like to attend an experimental demonstration of the extraction of metallic sodium from stoneware, and we would permit the demonstrators to choose for themselves the most favourable conditions. We fear, however, that we shall have to wait a very long while for this gratification.

Our estimable contemporary is at one with us in believing that under the influence of moisture the metal sodium is turned into caustic soda as soon as it is liberated; but what in the name of Sir Humphrey Davy, who made the subject peculiarly his own, are the "conditions which may easily and do arise" under which "particles of metallic sodium remain;" and will our estimable contemporary produce the "schoolboy" who knows that "by mere contact with a drop of water" "*active combustion* is produced?"

The remedy proposed by our estimable contemporary is, as it lightly puts it, to "abandon the ginger beer bottle material which is but a poor insulator, since when moist it actually becomes an electrolyte, and to adopt glass;" but before it can hope to succeed in persuading the electrical companies and vestries to follow this sage advice, we think it will have to produce a scientific explanation of the drawbacks connected with stoneware, based, not upon mere newspaper dialectics, but upon the results of searching experiment.

The pitiable Board of Trade (for we bear it no ill-will) has, metaphorically speaking, admitted a *non possumus*, and gone down upon its bended knees before the Institution of Electrical Engineers and the Royal Society, and implored the favour of their assistance. We do not expect it to extract much from the Institution, for this body has shown itself so far singularly indifferent to the interests of the trade in connection with these recurring explosions. It is odd, perhaps, that with its evident tendency towards chemistry the Board of Trade has not also invoked the assistance of the Chemical Society and of the Society of Chemical Industry. However, whilst it is waiting for light to lighten its darkness, we would humbly suggest to it, since it is so fond of chemistry, a couple of theories and a course of reading from which it may possibly extract some new ideas. And since our estimable contemporary, the *Electrician*, has exhibited its chemical proclivities and paraded its vast acquaintance with chemical lore, it may not be amiss for it to follow suit.

Theorem 1.—Coal-gas escapes from the gas-mains and finds its way through the soil into the junction boxes and conduits. Coal-gas contains acetylene and ammonia, the latter being limited by legislation to 4—5 grains per 100 c.c. Some electric light conduits have bare copper cables. Acetylene in the presence of a trace of ammonia will combine with copper to form a highly unstable and

explosive compound, variously termed copper-acetylene, cuproso-vinyl-oxide, &c. Accidents have been recorded which have been caused by the formation of this unstable compound in copper pipes and vessels through which coal gas has passed. Therefore coal gas should be kept out of electric light conduits.

Theorem 2.—Coal gas contains acetylene. Sodium is found, so the Board of Trade says, in electric light conduits, &c. Coal gas finds its way into these conduits. Now sodium-acetylene is decomposed, when water is brought into contact with it, with explosive violence. Therefore coal gas should be kept out of electric light conduits.

Now for the course of reading:—Böttger, *Liebig's Annalen der Chemie*, cix., p. 351; Berthelot, ditto, cxxxviii., p. 345, and cxxxix., p. 150; Blochmann, ditto, clxxiii., p. 174; Berthelot, *Bulletin de la Société Chimique de Paris* [2] v., p. 191. After this course of reading, and a due consideration of the above theorems, the Board of Trade and our estimable contemporary may possibly discard their own theories, and invent some new ones.

We evidently cannot bring our opinions entirely into line with those of the Board of Trade or the *Electrician*; but our attitude can nevertheless be gathered from the foregoing remarks. First, it is clear that the alleged cause "discovered" applies only to cases where bare cables are installed, and does not exercise any bearing upon the number of explosions which have been occasioned on high tension circuits where the mains have been heavily insulated; these have been the seat of nearly all the explosions recorded to date. Again, is it not a fact that explosions are on record which have taken place before the electricity has been completely installed—*e.g.*, we know of one instance, amongst others, in which the *pipes only* had been laid for a high tension system, and yet before the cables were drawn in a remarkable explosion took place?

Whatever may be the immediate proximate causes determining the explosion when it takes place, it is notorious that the gas companies are responsible for the material which supplies the explosion. The soil in the streets and pavements literally reeks of coal gas, whenever it is interfered with; and the companies themselves allow that a large percentage of their output is wasted in leakage from their mains. The increasing use of asphalte and wood pavement has aggravated the evil, inasmuch as it has supplied a non-porous covering for our streets. Consequently the electric conduits and junction boxes, &c., are invaded by coal gas, which, mingling with the air there, soon forms a highly explosive compound. Until we can compel the gas companies to prevent the escape of coal gas from their mains, any means which electricians adopt will probably be only palliative, not preventive.

The only public body, as yet, on the right track, so far as we have been able to ascertain, is the Islington Vestry. At their meeting on March 1st last, amongst the agenda was the following:—

To receive a report from the Electric Lighting Committee—

Stating that having considered a report from the electrical engineer (Mr. Albert Gay) calling attention to the fact that electric lighting enterprise is being prejudiced by the explosions of gas occurring from time to time in electrical conduits, and to the possible danger to life resulting from such explosions; it *recommends* that a memorial be presented to the Board of Trade urging that steps should be taken by legislation or otherwise to obtain greater control over the gas companies as regards any escape of gas from their mains, and that a copy of such memorial be forwarded to the other Metropolitan Vestries and District Boards, and to the several Metropolitan electric lighting authorities, with a request that they will make similar representations.

This report was unanimously adopted by the Vestry. Now, if only the other Metropolitan Vestries, District Boards, Provincial bodies, and electric light companies, follow the lead of the Islington Vestry, the result will be at least to bring matters to a head, so far as the gas companies are concerned. If we can succeed in eliminating the explosive material that invades our conduits and street boxes, there will be time enough then to elaborate ingenious chemical theories to account for the proximate causes of explosions. It is more likely, however, that we may be called upon then to invent theories to account for the absence of such explosions.

The Niagara Dynamos.

Prof. George Forbes's patent was unknown to us at the time of writing, but there can be no great value in a claim which is limited strictly to revolving a magnet, outside an armature instead of inside; practically and scientifically there can be no invention in that. Downward pressing weight was necessary on the shaft of the turbines at Niagara, therefore an external armature has an advantage there, as it is much heavier than an internal magnet, and that is all the advantage which can be claimed for it. We repeat there is nothing new or interesting in revolving an external field magnet, being an equivalent only to revolving an internal field. Time was when Prof. Forbes sneered at the slavish copying of dynamos by makers who simply altered some unimportant disposition of parts, or some arrangement of brushes, and called the machine a new departure. He once went so far as to say that some makers produced a new dynamo by merely altering the colour of the paint or casting another name on the framework. We fail to see any new departure of importance in merely designing an external revolving armature.

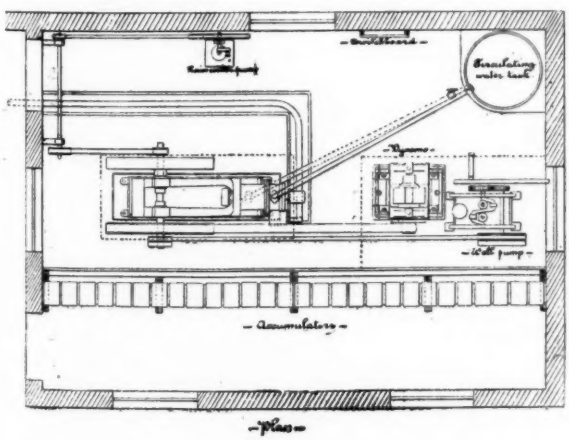
Carrying Capacity of Conductors.

According to the *Western Electrician* of January 26th last, the Underwriters' National Electric Association, of America, have recently issued a table of the safe-carrying capacity of various size conductors in "Brown & Sharpe gauge" for interior work, in which they introduce the novelty of distinguishing between "concealed" and "open" work, allowing approximately 30 per cent. more current where the conductors are carried in "free air" than when encased or otherwise concealed. However sound in theory such a refinement as this may be, we doubt very much the expediency of putting it into practice. To begin with, the tables apparently allow a rise of temperature due to current of about 15° C.—a latitude sufficient in all conscience, and one that can never be approached in practice under normal conditions without a considerable loss in volts. To issue an arbitrary table of the kind without a word of caution or explanation as to its application, and with the dictum that it "must be followed in the placing of interior conductors," is likely to lead the unwary into trouble, and seems to provide an elegant trap for the plumber-electrician. We note also that the Association are waging war against the house of Edison, having elected to proceed by resolution—it being "*Resolved*:—That the practice of grounding the neutral wires on the Edison tube system is a constant menace to the properties lighted thereby." This is by no means the first attempt on the part of American underwriters to abolish earthing the central wire, and the resolution may, therefore, possibly resolve itself into a mere pious opinion.

A PRIVATE HOUSE LIGHTING PLANT.

Modern house lighting plant is not usually of a pretentious nature. It is worth some consideration, however, if merely for the fact that it has provided a good deal of business during the past two or three years. Very many are the country houses which are now equipped with electrical plant sufficient for lighting and small power purposes, and with the great improvement that has been effected in oil engines, there should be a still further use of this plant. We advisedly say oil engines, because under many conditions obtaining in the country, gas motors would scarcely be practicable.

We have selected the following instance of a private house lighting plant, not that it presents any very novel features,



Plan.

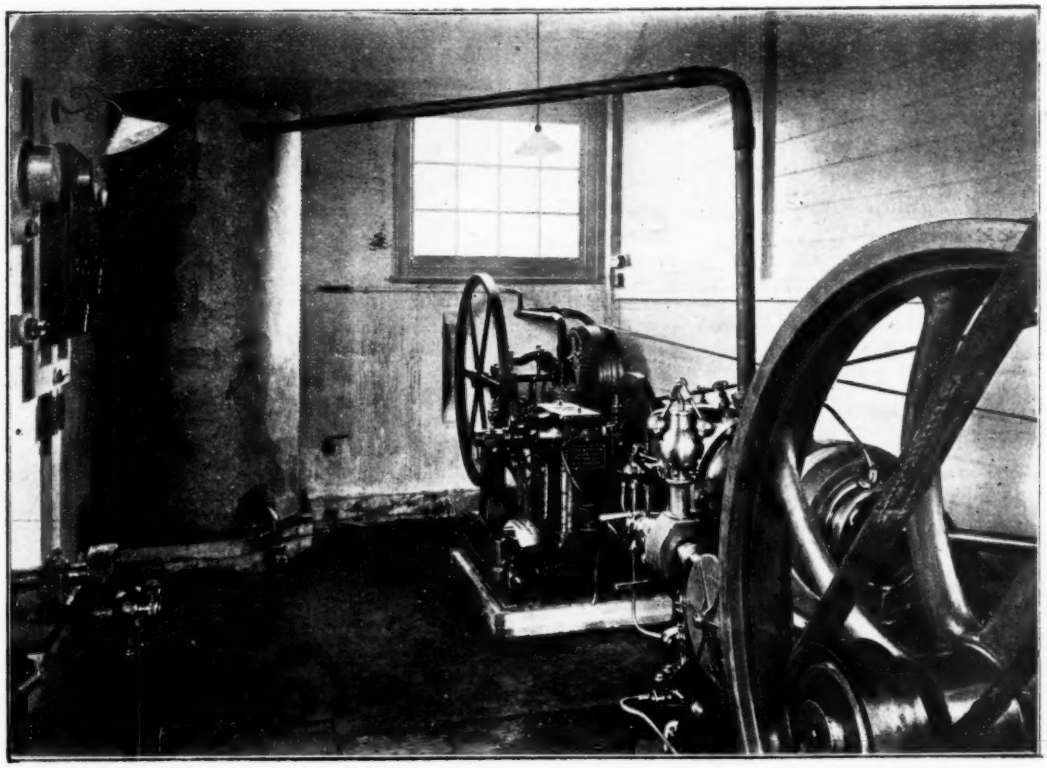
but because it is a good example of the arrangement of plant suitable for the electric lighting of a country house.

The residence we have selected is one which has been recently built at Amersham.

The plans and specifications of it were prepared by Messrs. George Head & Co., and the work was carried out by Mr. George Darlington, a local contractor.

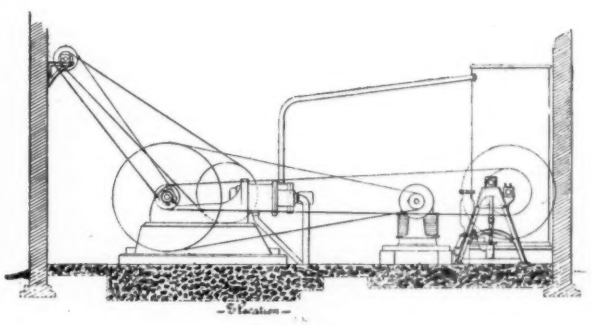
We are not a bit interested, however, in the building. Our interest is completely involved in the engine room, which is arranged near the house.

The plant consists of a Hornsby-Akroyd oil engine driving an Elwell-Parker dynamo. In addition, however, the engine is working two pumps for hard and soft water. A battery of accumulators is arranged in a portion of the building



divided off from the engine room proper. An idea of the arrangement, however, will be best obtained from the drawings.

As we have already said, the engine room is fixed conveniently near the main building, and in order to get rid of the smell, a 6-inch pipe is taken underground for a distance of something like 60 yards, which is no doubt a cheaper and



Elevation.

better plan than fixing the engine and accumulators at that distance. There are altogether about 130 incandescent lamps used in lighting the house and stables. As we have not previously described the Hornsby-Akroyd engine, this might be a favourable opportunity for giving a few of its details. As will be seen from the illustration, it is a horizontal engine, and in appearance and design somewhat similar to a gas

engine, the well known four-cycle plan of operation being used.

The engine is constructed with a working cylinder closed at one end by a cover and open at the other. In this cylinder the piston, which is formed like a plunger, works, being open at one end to receive the end of the connecting rod. The connecting rod is attached at its other end to the crank. Near the closed end of the cylinder a valve box is fitted, which contains two valves, one being the air valve and the other the exhaust. The air and exhaust valves are opened by separate levers, each lever being moved by a cam mounted on a horizontal shaft driven by the crank shaft through skew or bevel wheels. This horizontal shaft makes only one revolution, whilst the crank shaft makes two, so that the air and exhaust valves are each opened only once every two revolutions.

At the back of the cylinder is a cast-iron box, called the vaporiser, which is always open to the cylinder through a neck. This vaporiser is heated before starting the engine by an internal lamp, blown by a small hand fan, for a few minutes. This is done so that the vaporiser shall be able to vaporise and explode the oil when it is pumped into it. After the engine has started running, the lamp is no longer required, the vaporiser being kept at a sufficient heat by the explosions which take place.

A small oil pump worked by the air valve lever draws oil from the oil tank under the engine, and forces it into the vaporiser; this takes place only during the outstroke of the piston when it is drawing in air. The oil on its way to the vaporiser from the pump passes through a valve box attached to the vaporiser. This valve box has two valves in it, one kept closed by a spring which the oil forces open as it goes into the vaporiser; the other also kept closed by a spring, and should the engine run too quickly, the governor opens it and allows some of the oil to run back to the tank. This valve can also be opened by turning the little regulating handle provided, which will stop the supply of oil to the vaporiser, and thus stop the engine.

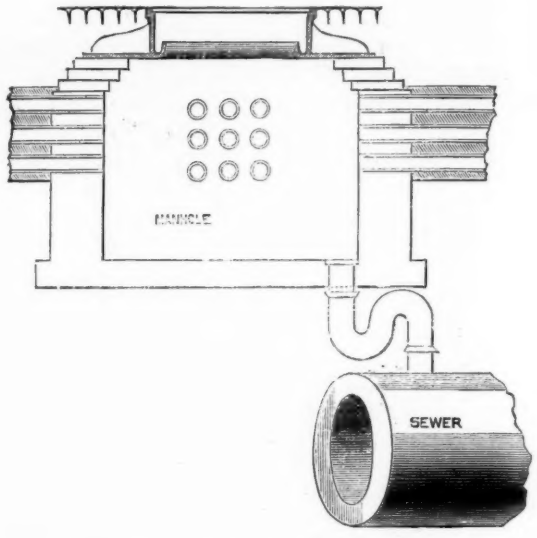
The action of the engine generally may be explained as follows:—The vaporiser having been previously heated, and the fly-wheel being pulled round, the first out-stroke of the piston thus made will cause the air to be drawn into the cylinder, and at the same time the pump will force oil into the vaporiser; the oil being transformed into oil vapour by the heat of the vaporiser. On the return stroke of the piston the air is compressed into the vaporiser, and thereby mixed with the oil vapour, and just as the piston gets to the end of its stroke an explosion takes place, which forces the piston out on its second out-stroke. When the piston gets to the end of this stroke the exhaust valve opens, and the return stroke expels the gases; the same cycle of operations being repeated continuously.

The speed of the engine is governed by a small Porter governor, which acts through levers on an overflow valve fitted in the valve box attached to vaporiser, so that when the engine runs too quickly this valve is opened by the governor, and the oil allowed to return to the tank instead of going into the vaporiser. The vaporiser getting little or no oil, the speed of the engine is thus regulated.

Many oils can be used for running these engines, and of a specific gravity of ·8 to ·88, and with a flashing point up to 250° Fahr.

VENTILATING SUBWAY MANHOLES BY SEWER CONNECTIONS.

In a recent issue of our New York namesake appeared a letter from the National Conduit Manufacturing Company, describing the system adopted by them for ventilating subway manholes by sewer connections. They say that since the recent explosions in the subway manholes in Brooklyn, Boston, Rochester and Philadelphia, there has been more or less talk among electrical men as to the best way to remedy this trouble. They have built during the past five years subway systems in the different cities in the United States containing nearly 10,000 manholes. In their street railway work in Chicago, in Philadelphia, and in Boston, in every instance where they were above the sewer, they made a connection to the sewer with a trap, as is shown in the accompanying sketch. They have not a single instance where there has been an explosion in any manhole in which this connection was made. In Chicago, in addition to this connection, every manhole cover is ventilated, the same as a sewer manhole cover. There have been positively no explosions of any description in any manholes in America that have been connected to the sewer, and the manhole cover ventilated. The explosions that have occurred have been in

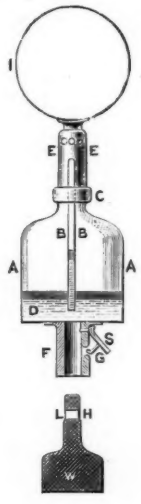


manholes that were neither connected to the sewer nor the cover perforated, so as to permit ventilation. This would naturally cause the remark that those manholes will fill with dirt, but from experience the dirt that has accumulated in a month in a manhole in the heart of the business district of Chicago has been removed in 10 to 15 minutes time by two men. The explosions that occurred in Brooklyn not only caused a serious inconvenience and expense by the destruction of the manhole, but also broke the conduit, which was terra cotta, for a very considerable distance from each end. The explosions in Philadelphia occurred in a conduit system built of wood. This, in addition to destroying the manhole, caused the conduit to catch fire, and it was burned some distance from each end. Fortunately for the companies involved, there were no cables in either of these places. Had there been cables the expense would have been very much greater. The company claims that very probably both of these explosions would have been avoided had the manholes been trapped to the sewers, and the covers ventilated. Certainly the destruction of the conduit would not have occurred if some other form of conduit had been used. There was an explosion at the corner of Thirteenth and Ridge Avenues, in Philadelphia, at the main manhole of the Philadelphia Traction Company's conduit system, and the only damage done was that the manhole covers were lifted and thrown across the street. The conduit system, which is cement lined pipe, showed nothing more than a slight blackening on the sides of the conduit. This manhole, from the fact of its being a very large one, having 270 ducts coming into it from the four sides, necessarily made the bottom of it considerably below the sewer, so that it was impossible to connect this manhole to the sewer. All manholes of the Philadelphia Traction Company, more than 4,000 in number, are trapped to the sewer wherever it is possible to do so. They get ventilation in Philadelphia, not from the cover being perforated, but from a feed pole, which connects with every third manhole, and gives as good, if not better, ventilation than a perforated cover. The Chicago Telephone Company, of Chicago, were the first company in America to connect their manholes to the sewer and ventilate the covers. They understand that there has never been an explosion in any of their manholes built according to this plan. They have been in use since 1888, and some of them are in streets where the escape of illuminating gas is so much, that it is almost noticeable through the paved streets.

DEEP-SEA SOUNDING IN 1733.

In the beginning of last century an instrument for "measuring the unfathomable depth of the sea," was invented by Dr. Stephen Hales and Dr. Desaguliers, both eminent divines and philosophers, and both members of the Royal Society. An account of this invention was, we read, published in the *Gentleman's Magazine* for 1753. The description, of which we give an abridged account below, was drawn up by Dr. Hales "for Colin Campbell, Esq., who employed the ingenious Mr. Hawksbee to make the machine it describes, which was tried in various depths, and answered with great exactness, yet was at last lost near Bermuda."

The sounding apparatus, which is founded upon the application of Boyle's law, is shown in the sketch, and may be



shortly described as follows :—A, A, is the "gage-bottle," in which is cemented the "gage-tube," B, B, at the collar, C. The upper end of the glass tube, B, is hermetically sealed, the open lower end being immersed in mercury, D, on the surface of which floats a "small thickness" of treacle. On the top of the bottle, A, is screwed a brass tube, E, which is pierced with several holes to admit the sea-water freely into the bottle, A. The body, W, is a weight which hangs by the shank, L, in the tube or socket, F; this weight is suspended by pressing the spring, S, until the trigger, *g*, fits into the slot, *h*, in the shank of the weight, which being suspended thus on the trigger, hinders the spring from flying back to its normal position. The hollow sphere or bladder, I, attached to the top of the brass tube, E, must not have flotation enough to prevent the whole apparatus from sinking when the weight is attached. The instrument thus prepared is let go in deep water, and in its descent the increase of pressure causes the column of mercury on which the treacle floats to rise in the "gage glass." On touching the bottom, the strain of the weight is taken off the trigger, which thus released, is withdrawn from the slot by the spring; without the weight, the hollow sphere has flotation enough to raise the remainder of the apparatus to the surface of the ocean. The treacle mark on the inside of the glass tube registers the amount of pressure to which the enclosed air has been subjected, and from this a knowledge of the depth is obtained. Observing that as the depths increased the difference of compression was scarcely noticeable, Dr. Hales introduced a hollow sphere in the lower part of the tube; for greater facility of reading off the pressure, he also etched a scale on the glass tube.

Another simple instrument was contrived by Dr. Hales: A hollow cylinder, with the orifice at each end closed by flap valves, opening upward. This cylinder, containing a thermometer, was fastened on to a sounding line, close above a sinker. In going down through the sea, the water had free passage through it; but when being pulled up the valves closed, imprisoning the water contained in the tube at the greatest depth to which it was lowered. The result of several trials with this apparatus was, that when it was let down to different depths (from 60 fathoms to 890 fathoms) in lat. 25° 13′ N. and long. 25° 12′ W., or about 500 miles north of the Cape de Verde Islands, it was discovered that the thermometer showed a gradual diminution of temperature as the depth increased, till it reached 650 fathoms, when the thermometer, on being brought to the surface, showed 53°, the surface temperature being 84°; and although the apparatus was sunk to 890 fathoms, the thermometer, on reaching the surface, was no lower. It was also observed that the water "brought up from below was found to be heavier, and consequently the saltest," in comparison with the surface water.

The above account may prove interesting to our readers, as showing the state of knowledge on this subject some 150 years ago. Curiously enough, there is a sounding made by H.M.S. *Challenger* close to the spot above referred to, which shows the depth to be 2,740 fathoms, and other data would lead us to expect at a depth of 650 fathoms in that part of the ocean a temperature of about 47°. All credit, however, is due to these worthy divines, who throw a light on a subject which, although then of only theoretical interest, has since become of the greatest importance in connection with the laying of electric telegraph cables.

REVIEWS.

The Engineer's Year Book of Engineering Formulæ, Rules, Tables, Data, and Memoranda, 1895. By H. R. Kempe. London: Crosby, Lockwood and Co.

This year book has entered on its second year of publication and is considerably enlarged, the index now filling 17 pages as against 16 in the first year's issue, but being printed on thinner paper it is little more bulky, and the new contents are thus all gain. The table of logarithms has been much amplified, and all matter taken from annual reports, such as Board of Trade returns, &c., has been corrected to date. The section on refrigeration has been extended, and in the section with steam engines, Professor Cotterill has been followed in the formulæ and tables of properties of steam, whilst details of American stationary practice have been incorporated. Some of the leading engineers of Lancashire and Yorkshire have been drawn upon for a new section on cotton mill practice, and there are numerous fresh subjects included among the more miscellaneous branches, while Professor Claxton Fidler has rewritten the bridge and girder section; this alone should be a sufficient guaranty of this part of the work.

Useless and obsolete tables have been omitted and space saved in other directions. A description of the Forth Bridge for example, good enough in the right place, but not of sufficiently general interest to the ordinary engineer, who is not building Forth Bridges every day, is wisely omitted in the new edition. A year book of this type should deal with the thousands of items needed by the majority. The structures that mark an epoch have sufficient importance to own a literature of their own, and in this 1895 edition an endeavour has been made to bring the work up to date and eliminate much that was useless in the first edition. As it now appears, the Year Book is fairly in shape—a task which must have involved great labour, but there are few pages not of great value. The very numerous tables are printed with great excellence. Indeed, the whole get up of the book has been from the first of the very best in type and paper, and reflects credit on the printers, Messrs. Spottiswoode & Co., and if the annual revision is to be continued, when necessary, we do not doubt but that the work will continue one of standard reference.

Spon's Architects' and Builders' Price Book, 1895. By W. Young. London: E. & F. N. Spon.

This annual publication continues to be brought to date year by year, and is, on the whole, a very fair guide for the basis of estimates for the engineer and architect. It is useful to the electrician chiefly as an aid in the approximate valuation of proposed works, and the checking of contractors' estimates, a large portion of the book being necessarily abstracted and condensed from manufacturers' price lists, and the actual cost being often capable of reduction in practice. As a rule, with the prices in this book we have

found that in estimating on work outside the ordinary run, the figure arrived at has been such as with ordinary care will leave a margin for profit.

The Electroplater's Handbook. By G. E. Bonney. London: Whittaker & Co., 2, Hart Street, Paternoster Square. Second edition.

The new edition of this book has received additions in the form of short sections on "frosting gold," "stopping-off varnishes," and "rates of deposit" for the principal metals in use by electroplaters.

Long-Distance Telephony. By Aug. E. R. Collette, Engineer of the Netherlands Telegraphs. Translated from the Dutch.

This pamphlet of 33 pages is an official translation of articles which appeared in Nos. 45 and 46 of *Weekblad de Ingenieur*. Although it does not contain much, if anything, that is new, it is a most excellent compilation of interesting information which has appeared within the last few years in various papers (including the pages of the Review); the effects of self and mutual induction are very well enunciated; the various formulæ for inductive capacity are given, and the K R law is explained. Full details of long telephone lines are also given, including the London-Paris circuit. The results of telephone experiments on the Lowestoft-Zandavort cables are also fully referred to. Altogether the compilation is deserving of being brought out in book rather than pamphlet form.

An Introduction to the Theory of Electricity. By Linnæus Cumming, M.A. London: Macmillan & Co. Fourth edition.

The chief additions to this well-known excellent book consist of articles upon the magnetic circuit and on the dynamo. The additions are not extensive, and might, with advantage, have been made rather fuller without unduly adding to the bulk of the book, but of their kind they are entirely in harmony with the general design of the work.

Electrical Engineering for Electric Light Artisans and Students. (Embracing those branches prescribed in the syllabus issued by the City and Guilds Technical Institute). By W. Slingo and A. Brooker. With 346 illustrations. New and revised edition. London: Longmans, Green and Co.

The present issue is practically the sixth edition of the work, the latter having been four times reprinted, and now revised.

The authors are careful to explain in the opening chapter the various phases through which the value of the ohm has passed, and it would have been advantageous if the resistances in the table given on page 19 had been reworked out to true ohms instead of being left in Paris ohms, since these are quite obsolete. We notice that the definition of "current strength," to which we took exception in reviewing the first issue of the book, has been revised and is now quite correct. In the chapter dealing with batteries there are several new features; the "dry" cell battery, which, we believe, was not described in the original edition, being now fully explained. The authors have some sensible remarks to offer with reference to the use of primary batteries for electric lighting purposes.

In describing the Post Office tangent galvanometer we notice that an old pattern is illustrated, the most recent form, which has superseded the old for some little time, not being alluded to. All the chapters, however, which deal with galvanometers, testing instruments, ammeters, voltmeters, &c., are very diffuse and satisfactory, the explanations being excellent.

Of the chapter dealing with dynamos little need be said; the authors are evidently well impressed with the necessity of bringing their work well up to date, and they have done so. Secondary cells are now explained in a chapter of forty-four pages, and lamps, both arc and incandescent, receive full attention. To go through the whole work in detail is unnecessary. Messrs. Slingo and Brooker's original work had a deserved reputation, and the present revised issue should very considerably enhance the same.

Journal of the Institution of Electrical Engineers, No. 114. London: E. & F. N. Spon, 125, Strand.

The principal contents of this number are as follows:—"Notes on Electric Tramways in the United States and Canada," by H. D. Wilkinson; "Electric Traction, with Special Reference to the Installation of Elevated Conductors," by R. W. Blackwell and P. Dawson; "Electrical Steep Grade Traction in Europe," by C. S. Du Riche Preller.

Matriculation Directory, No. xvii., January, 1895. University Correspondence College, 32, Red Lion Square, W.C.

In the principal's report it is stated that 740 students have been successful at the London University, a highly creditable result. The list of examination questions with solutions, at the end of the book, is a most useful feature and almost raises the directory to the position of a text book.

Twentieth Annual Report of the Yorkshire College, Leeds.

It is quite needless to emphasise the good which this class of college is doing. A steady development in the work is noticeable, though in the matter of finance there has been cause for regret that it has not been as satisfactory as could be wished.

TRANSMISSION OF POWER AT SIEMENS'S, AND OTHER THINGS.

It is a little more than two years ago that an experiment in electric transmission was inaugurated at Messrs. Siemens's Woolwich factory. The experiment was designed to be a large one, and included the complete abandoning of scattered steam plant in favour of electric motors deriving their energy from a central station. It goes without saying that the result of Messrs. Siemens's experience has been awaited with considerable interest. We tried to anticipate matters a little, when some months ago we published two special articles on the application of electric motors; our efforts towards being a little previous, however, were not altogether successful, for though we gave some interesting facts concerning the use of motors at Siemens's, figures relating to cost were withheld, because, as Mr. Alexander Siemens contemplated making a communication to one of the learned societies on the subject, it was rightly felt that he had the first claim to use such results. Mr. Siemens has read his paper before one of the learned societies—the North of England Institute of Mining and Mechanical Engineers—he has given some interesting information, and with a little trouble it is possible to ascertain more or less accurately what it might cost to run electric motors. More than this, however, Mr. Siemens has collated some most interesting facts concerning the comparative running of the Willans and Belliss engines. Without any desire to set either of these contractors by the ears, and yet perfectly conscious of a battle by correspondence which waged in the Review not long ago, we shall have much pleasure in publishing some of these comparative figures. For the moment, however, we will return to the special conditions which prevail at the Siemens workshops.

The central station from which energy is derived both for motive power and lighting purposes, contain five two-flued multitubular boilers, each 18 feet long and 9 feet in diameter. They are hand stoked, and supply steam to the machinery of the central station, to the steam engines driving the gutta-percha shop, and for heating purposes.

In the engine room, which measures 42 feet by 30 feet, there are four steam dynamos, each capable of giving a current of 1,500 ampères at 120 volts pressure, when running at 350 revolutions per minute. All four dynamos are exactly alike, being two-polar drum armature machines of the Siemens

H.B. 24/36 type, shunt-wound, and fitted with switch and resistances for varying the exciting current by hand. Three of the dynamos are driven by three Willans III. compound condensing single-acting engines, and the fourth is coupled to a Belliss compound condensing double-acting engine.

The four generating sets are coupled in parallel to an omnibus bar, from whence the main cables are laid to the various departments, a safety fuse and an indicator being fitted in each circuit. Provision is also made on the switchboard for coupling two of the generating sets in series, when a current of 240 volts pressure is required at any part of the works. The total length of cable laid between the switchboard in the engine room and the distributing boards in the various departments is a little over 18,000 feet.

Each department has its distributing board to which the current is brought from the central station by one or more main cables; it is fitted with a registering meter, and with fuses for the branch cables which lead to the various motors in the department.

Quoting from Mr. Siemens, we find that "at the present time 72 motors are in use, varying in size from 100 to one-sixth of a brake horse-power, and capable of giving a total of 1,407½ brake horse-power.

"The output of the central station is 1,200 indicated horse-power, which (with an efficiency of 86 per cent.) gives 1,130 electrical horse-power available at the central station, or, roughly, 1,000 brake horse-power at the motors in the workshops.

"With regard to these figures, it should be remembered that the whole plant is capable of producing from 25 to 30 per cent. more output, when required for a few hours, without any danger of straining any part of it, and this is the safeguard to which the author has already called attention, and which ensures the satisfactory working of suchan installation

"Before the electric transmission was introduced, 18 steam engines were employed, capable of yielding altogether 1,446 indicated horse-power. These correspond to about 1,150 brake horse-power, then available for driving machinery. Seven of the old steam engines, giving about 380 brake horse-power, are still in use, so that the total power now at disposal for motive purposes is 1,787 brake horse-power, while, in addition, the central station furnishes current for 72 arc lights and about 1,600 16-candle-power incandescent lights.

"A comparison of these figures will at once show that the works have been considerably extended since the first steam dynamo was started, on June 20th, 1892, and for this reason it has been rather difficult to find out how the cost of power at the present time compares with that of working steam engines alone.

"Another circumstance which made such an inquiry complicated was, that the work on a large cable contract this year increased all expenses of fuel and labour to such an extent, that the preceding years cannot be compared with it in order to determine the exact saving that has been effected.

"In former years cable work of equal duration increased our consumption of coal by nearly 5,000 tons; but this year the increase has not been more than about 2,000 tons, so that an actual saving appears to have been effected of about 3,000 tons of coal.

"The steam engines and boilers of the old installation were tended by 10 stokers and nine engine drivers, while at the present time eight stokers are employed, of whom three attend to the old boilers still in use, and five engine drivers, three of whom attend to the old engines.

"The electrical part of the machinery in the central station is attended to by one electrician and a boy, while the motors are attended to by the oilers of the various departments.

"When the arrangements are completed, all auxiliary boilers will be abolished, and a farther saving of attendants will be effected.

"As far as they go these comparisons prove that the electric transmission has been economical."

In order to obtain satisfactory information as to the performance of the plant, a series of tests were made. We do not think that it is necessary to detail the apparently very careful and elaborate methods adopted. We are not condemning Mr. Siemens's paper when we say that a great, a very great portion of it deals with the comparative efficiencies of the Willans-Siemens and Belliss-Siemens plants. The tables showing the five hours' tests of a Willans III. compound condensing, and of a Belliss compound condensing, coupled to Siemens machines, under almost equivalent conditions, are distinctly interesting. What these engines may do or may not do is of primary importance in the ultimate cost of running electric motors.

"The water evaporated per boiler per hour was 5,576 lbs. The weight of water evaporated per lb. of coal (including coal used in lighting fires) into steam at a pressure of 127 lbs. per square inch was 8·923 lbs. The weight of water evaporated per lb. of coal from and at 212° Fahr. was 10·083 lbs. The weight of water evaporated per square foot of total heating surface per hour was 4·42 lbs. The

FIVE HOURS' TESTS OF A WILLANS III. COMPOUND CONDENSING ENGINE (No. 2), OF 300 INDICATED HORSE-POWER, COUPLED TO SIEMENS H.B. 24/36 DYNAMO, 1,500 AMPERES AND 120 VOLTS, AT 350 REVOLUTIONS PER MINUTE.

Experiment.	Indicated Horse-power.	Volts.	Ampères.	Watts.	Electric horse-power.	Board of Trade units.	Pounds of coal per			Pounds of steam per			Efficiency. Col. 5. / Col. 1.
							Hour per indicated horse-power.	Hour per electric horse-power.	Board of Trade unit.	Hour per indicated horse-power.	Hour per electric horse-power.	Board of Trade unit.	
													Per cent.
1	95·75	120·7	376·2	45,407	60·87	227	2·29	3·945	5·28	20·5	35·2	47·15	63·6
2	149·2	120·05	712·3	85,511	114·6	4·7·5	2·35	3·06	4·10	21·0	27·3	36·6	76·8
3	209·8	119·75	1,106	132,443	177·5	662·2	2·24	2·656	3·55	20·03	23·7	31·7	84·6
4	268·9	118·2	1,459	172,453	231·2	862·3	2·18	2·545	3·41	19·5	22·7	30·45	86·0
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)

FIVE HOURS' TESTS OF A BELLISS COMPOUND CONDENSING ENGINE (No. 1), 300 INDICATED HORSE-POWER, COUPLED TO A SIEMENS H.B. 24/36 DYNAMO, 1,500 AMPERES AND 120 VOLTS, AT 350 REVOLUTIONS PER MINUTE.

Experiment.	Indicated horse-power.	Volts.	Ampères.	Watts.	Electric horse power.	Board of Trade units.	Pounds of coal per			Pounds of steam per			Efficiency. Col. 5. / Col. 1.
							Hour per indicated horse-power.	Hour per electric horse-power.	Board of Trade unit.	Hour per indicated horse-power.	Hour per electric horse-power.	Board of Trade unit.	
													Per cent.
1	79·4	120·02	376·0	45,127	60·49	225·6	2·99	3·91	5·24	26·7	34·9	46·8	76
2	144·75	120·05	747·6	89,749	120·3	448·7	2·72	3·28	4·39	24·3	29·25	39·2	83·3
3	212·8	120·32	1,116·8	134,373	180·12	671·9	2·48	2·94	3·94	22·2	26·26	35·2	84·7
4	271·6	121·22	1,418·0	171,890	230·4	859·5	2·51	2·95	3·95	22·4	26·33	35·3	85·1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)

weight of water evaporated per square foot of grate area per hour was 136 lbs. If the coal used in lighting up be neglected, the evaporative efficiency becomes 9·16 lbs. of water per lb. of coal at a mean pressure of 127 lbs. per square inch, and 10·35 lbs. of water per lb. of coal from and at 212° Fahr.

"The annexed experiments were made on steady loads (resistance frames) :—

DAY-LOAD TESTS OF FIVE HOURS, THE VARIATION OF LOAD BEING ABOUT 15 PER CENT.

	Willans engine, &c.	Belliss engine, &c.
Mean current (ampères)	1,167	1,184
Mean pressure (volts)...	121·33	126·38
Mean power (watts)	141,592	149,634
Mean electric horse-power	189·8	200·6
Board of Trade units	707·96	748·17
Weight of steam used per electric horse-power per hour (lbs.)	23·39	26·2
Weight of steam used per Board of Trade unit (lbs.)	31·35	35·1
Weight of coal used per electric horse-power per hour (lbs.)	2·62	2·93
Weight of coal used per Board of Trade unit (lbs.)	3·51	3·93
Proportion of full load	0·778	0·789

"These engines were not indicated, owing to the impossibility of taking simultaneous readings.

"From these experiments two diagrams have been prepared, one showing the steam consumption per Board of Trade unit per electric horse-power and per indicated horse-power, and the other the efficiency of the steam dynamos.

"It will be seen that the steam consumption of the Belliss engine was greater than in the Willans, but it should be stated that this was the first engine of its kind ever built of that description, and that it has the worst position as far as the exhaust steam is concerned. On the other hand, the efficiency shows to greater advantage in the Belliss set, the dynamos being identical.

"After the consumption of fuel and of water had been determined by these experiments, the value of the stores issued to the central station for the last six months was ascertained, together with the wages paid and the cost of the repairs done to the central station and to all the electric plant, including motors.

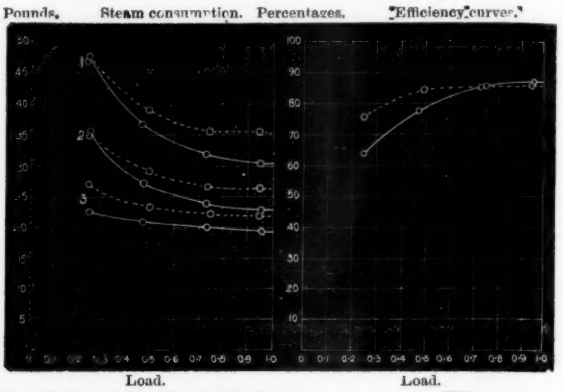
"The output of the station had been at the rate of 1,797,120 Board of Trade units per annum, representing a load factor of 0·285. The actual cost per Board of Trade unit was, therefore, for the six months ending October 31st, 1894 :—

	Per Board of Trade unit.	
	Willans. Pence.	Belliss. Pence.
Coal (including cost of delivery and removal of ash), 17s. 5d. per ton. Willans, 3·41 lbs.; Belliss, 3·95 lbs. per Board of Trade unit	0·3180	0·3680
Water (7½d. per 1,000 gallons)	0·0228	0·0264
Stores, oil, waste, boiler fluid, &c. (taken from last six months' consumption) ...	0·0416	0·0416
Wages, stokers, trimmers, drivers, labourers, electrical assistant (half-time, and switchboard boy)	0·0977	0·0977
Steam for auxiliary pumps, feed (only 0·7 taken, air and circulating), water 0·003d., coal 0·026d.	0·0290	0·0290
Repairs to central station plant and motors	0·0802	0·0802
Total cost per Board of Trade unit	0·5893	0·6429
Total cost per electric horse-power per hour	0·440	0·480

"The cost for steam supplied to auxiliary pumps, &c., is too high, as there was only one set exhausting into the main condenser during the tests, and the steam of one circulating pump and the air pump was charged to this set; probably a very little more steam would suffice for the full working load on the condenser.

"This cost is that of a Board of Trade unit at the switchboard in the central station. The loss of energy in the cables is not more than 5 per cent., and the average efficiency of the motor being taken at 90 per cent., the cost of a brake horse-power, or 746 watts, may therefore be taken at 0·515d. per hour.

"No attendance has been charged to the motors, and the expense of oiling is very trifling, especially in motors fitted with Meneely bearings, of which a model was shown. Such bearings were applied to the three bearings of a Siemens H.B. 15/20 motor, developing about 40 brake horse-power at 360 revolutions per minute in driving part of the machines in the lead-cable-sheathing shop. Two of the journals are $2\frac{3}{4}$ inches in diameter by $7\frac{3}{16}$ inches long, while the third is $3\frac{1}{4}$ inches in diameter by $6\frac{7}{16}$ inches long. During the first



Curve 1 represents per Board of Trade unit.
" 2 " " electric horse-power.
" 3 " " indicated " "
——— Willans' set.
- - - - Belliss' set.

——— Willans' set.
- - - - Belliss' set.

week's run, one of the roller-bearings got rather hot, but not sufficiently so to necessitate stopping the motor; and since that time, the beginning of July, 1893, they have all been running satisfactorily. The consumption of oil, after the first few weeks, was at the rate of one pint per month for the three bearings.

"In order to make a comparison between the outlay for an electric plant, and for a steam-plant, the author has had a table prepared, showing the cost of the old steam-engines and boilers at Messrs. Siemens's works, together with the cost of foundations, erection, and of the chimneys. A statement, similarly, of the cost of the new boilers, of the pipe work, of the auxiliary engines, the condensers, the steam dynamos, the cables, motors, switches, and all accessories has been also prepared.

"In the old steam-plant of 1,446 indicated horse-power, taking into account the long lengths of shafting that had to be driven, the author does not think that more than 60 per cent. or 867 brake horse-power, was really utilised. On the other hand, there are now 1,407 brake horse-power available at the motors, and 240 horse-power devoted to electric-lighting purposes.

"The author does not wish to publish the exact costs, but the capital outlay per brake horse-power was 30 per cent. higher in the case of the old steam-plant, than for the present electric central station plant. Moreover, the load factor, viz., the proportion of the actual output of the central station to the possible output, which, as stated above, is 0·285, shows that we can connect to the present generating-plant many more motors without much fear of overloading it.

"There can, therefore, be little doubt that for new works electric transmission of power is certainly more economical than the employment either of separate steam-engines or of transmission by belts or ropes.

"Whether a change from the old system to electric transmission can be recommended depends entirely on local circumstances, and this question can only be ascertained by carefully weighing all the factors that come into play. Generally speaking, electric transmission is most applicable where power is wanted at a number of places scattered over the works, and especially in and about mines and collieries.

"Such a case has lately been investigated by the writer's firm, and they have made an offer to replace various engines, exerting altogether about 800 brake horse-power, by an electric plant, comprising a central station similar to that at Messrs. Siemens's works, but having only three boilers and three sets of steam-dynamos, all switches, cables, and motors to do the above work for a certain sum. By this conversion

the colliery owner would save sufficient money, counting 15 per cent. of his outlay for interest and depreciation, to repay the outlay in ten years, or in other words the cost of working the plant for a year would be less than the present cost by an amount equal to 25 per cent. of the outlay.

"These figures show that there is a wide field for successfully applying electric transmission of power, in works as well as in mines, where electric motors must be especially welcome, as they do their work without forming any bye-products that have to be dealt with by costly contrivances.

"In these times of ever-increasing competition it is well worth while to utilise all advantages that science places at the disposal of industry, and anything that increases the amount of power at our disposal for each pound of fuel consumed should meet with hearty support in this great centre of mining and industry."

Such is Mr. Siemens's paper. It cannot be gainsaid that it gives some most interesting figures concerning high speed steam engines, it contains also some fairly safe general remarks on the adoption of motors.

We would that Mr. Siemens had seen his way to give more precise figures as to original outlay, but we must be content with what we have received.

CORRESPONDENCE.

Ozone and Carbonic Acid.

Is carbonic monoxide C O *produced during the electrification of the air?*

I am not aware of any statement made by a scientist on the production of carbonic monoxide during the electrification of air in the ordinary process of passing air through an induction tube, or of using an open ozoniser. The presence of a large proportion of carbonic acid, and its long electrification, are very likely necessary for the production of even very little carbonic oxide. Besides, the percentage of carbonic acid in the air being extremely small, and the air not being submitted for any amount of time to the action of the electric effluvia, no carbonic oxide can be formed.

What happens if a stream of $C O_2$ *is treated with sparks or silent discharge? Will* $C O_2$ *be decomposed into* $C O + O$, *the latter gas being converted into* O_3? *Has thus treated* $C O_2$ *certain special properties or reactions?*

When induction sparks pass through carbonic acid gas, they decompose it rapidly. There is a certain limit to this decomposition, which goes back, increases again, decreases, and so on, without exceeding a certain point, because carbonic oxide and O tend to combine.

Berthelot has, during one hour, submitted to the action of sparks mixtures of carbonic acid and oxygen.

Carbonic acid	16·6
Oxygen	83·4

At the end of the experiment he found exactly the same volume of carbonic acid. The presence of an excess of oxygen prevents the decomposition (*Comptes Rendus de l'Académie des Sciences*, 1868).

(See also Thénard on the action of electric discharges on gases and vapours, *Comptes Rendus*, &c., 1875, p. 1,735; 1876, pp. 517, 1,048.)

In a mixture of two equal volumes of carbonic acid and oxygen, which he had submitted to the silent discharge during 12 hours, Berthelot found that $\frac{5}{100}$ths of the gas had been decomposed into carbonic oxide and oxygen; this oxygen contained a very strong dose of ozone and of percarbonic acid.

In the decomposition of carbonic acid by the silent discharge, some very interesting phenomena take place, which led Berthelot to suspect that percarbonic acid, $C^2 O^6$, exists.

This gas attacks with considerable energy mercury and oxidisable substances. If the oxidising part of this gas is ozone, the percentage of this substance would be enormous in comparison to the yield of ozone by the electrification of oxygen.

It would be rather long to describe the experiments in connection with ozone and carbonic acid. I must refer your correspondent, "Student," to the *Annales de Chimie et de Physique*, 5ème série, Vols. xx., p. 155; xxiv., pp. 441, 473; xvii., p. 144; xxxi., p. 544; *Comptes Rendus*, lxxiv., p. 1,280; Warren de la Rue and H. W. Müller, *Philosophical Transactions*, Part 1, clxxi., p. 65; clxix., p. 55; *Comptes Rendus*, &c., lxxv., p. 1,735; lxxvi., pp. 517, 1,015, 1,048, 1,203, and especially to the Mémoire by Thénard, lxxiv., p. 1,280. To conclude, the following extract from the celebrated paper by Sir B. Brodie (*Proceedings* of the Royal Society, 1873, page 483), will, I hope, satisfy your correspondent:—

"In my previous experiments, the maximum of ozone obtained by the action of electricity upon pure oxygen passed through the induction tube of W. Siemens was about 20 per cent., an amount which under the conditions of the experiment could not be exceeded. It occurred to me as possible to replace the 80 per cent. of oxygen unaffected by the action of the electricity by an indifferent gas, and thus to effect the complete conversion of oxygen into ozone. This idea was the starting point of the following investigations: When pure and dry carbonic acid gas is subjected in the induction tube to the electric action, a certain proportion of the gas is decomposed into carbonic oxide and oxygen, a portion of which appears in the form of ozone. The presence of this ozone may be detected by its odour, and the characteristic oxidation produced by it.

"It was a point of fundamental importance to determine whether the ozone thus generated was the same in kind as that formed by the action of electricity or pure oxygen, and whether the oxidations referred to were exclusively due to it.

"Now, in my investigations, I had discovered certain quantitative reactions of ozone, by which this substance is discriminated from all other known gases, and by which its presence may be detected and its quantity estimated. The electrised carbonic acid gas was examined by the aid of these reactions. . . . . 'These experiments conclusively demonstrate the identity of the ozone formed by the action of electricity upon carbonic acid gas with the ozone similarly generated from pure oxygen.'"

E. Andreoli.

Electric Currents in the Living Body.

Prof. Horsley's London Institute Lecture* of February 11th, however instructive as an exposition of certain points in electro-physiology, can scarcely be regarded as satisfactory from the standpoint of electro-therapeutics. After explaining the usually accepted physiological doctrines as to currents of action and currents of rest, and directing attention to the theoretical "action current" due to nerve impulses which he seems to consider he has now demonstrated in the spinal cord, Prof. Horsley passes on "from what is absolutely known" to deal with "the uses of electricity in treatment." To me it appears that the scope of electro-therapeutics is here so understated as to be little short of misleading. But passing over this point, attention may be directed to what follows. "It must be clearly understood that the use of the electric current is purely arbitrary, and there is no scientific evidence whatever proving that there is any quantitative acceleration or increase in the tissue changes in the manner indicated" (*i.e.*, by chemical changes in the tissues improving function and nutrition). For the following, as well as for other reasons, this cannot be accepted. D'Arsonval found that on submitting the body to the action of sinusoidal currents the so-called "respiratory capacity" of the blood, *i.e.*, the absorption of oxygen by the red corpuscles became notably increased. The extent of the increase was quantitatively determined; the extraction of the gases, and their collection for analysis, being carried out by means of the mercury pump. Now having in view the known correlation between the "respiratory capacity" of the blood and the nutritive activity of the tissues; knowing in other words that the absorption of oxygen at the lungs is an index and a direct result of tissue activity throughout the body, it follows that in altering the former we are influencing the latter, and that therefore in these currents we possess a means of altering the nutritive conditions of the whole body. Gautier and Larat have drawn attention to this point, and on their initiative these facts have been applied to practice. It is on such data that that large class of diseases due to failure or perversion of nutrition (maladies par ralentissement de

* Reported in the Electrical Review, March 1st.

nutrition, Bouchard) are successfully treated by means of the alternating currents of commerce applied in various ways. Gout, rheumatism, obesity, diabetes, and other diseases can be so treated, and the increase of "the oxidations" is manifested in the altered output of urea as well as in other ways. It is to what follows however in this lecture that attention may be more particularly directed. Prof. Horsley admits that "unquestionably improvement occurs, but (1) to what degree it is due to the electric current, or (2) in what way the latter may be supposed to act, are both points upon which no adequate research has yet given an answer." It may be suggested that an adequate answer to the former of these two points may be arrived at by simply applying the principle involved in what is known as "Mills method of difference" in establishing the casuality of an agent. Thus, a certain drug is regarded as a curative or a poisonous agent because certain effects follow its administration which without it would be absent. Let the action of electric currents be judged by a similar standard. As to the second point, present knowledge is, of course, lamentably defective; but it is to be remembered that the use of electrical energy in medicine cannot be considered more arbitrary nor more empirical (it is in reality a good deal less so) than is the employment of many a drug that at the present moment holds an honoured place in the Pharmacopœia. Compare electricity in this respect with three drugs in common use. When he prescribes mercury, quinine, or iron, the average practitioner, and perhaps even Prof. Horsley, considers himself on fairly firm ground. At least he would scarcely term his practice "purely arbitrary." Yet he does not know how mercury does its work; the action of quinine is, so far as I am aware, still *sub judice*, and admitting that the inorganic salts of iron are the proper treatment for chlorosis, who will demonstrate their mode of action? Is it on the principle of absorption, or of stimulation, or on what is known as the theory of Bunge? It is not intended to argue that the use of electrical energy is not empirical, because the use of certain drugs is equally or more empirical, but simply to point to the fact that the relationship of cause and effect need not be doubted, because the *modus operandi* is not quite clear, and that a *propter hoc*, which is freely admitted in the case of drugs, need not be doubted in the case of electricity. The matter stands thus: On subjecting the body to certain electrical currents, certain alterations in the nutritive exchanges demonstrable by the usual physiological methods are found to follow, and in the absence of such currents there is an absence of such results. I venture to submit that this forms an objective basis on which to found a rational treatment, and that practice based on such data is something more than "purely arbitrary." When Prof. Horsley stimulates the nerve of an animal with an electric current and a muscle moves in response, he does not doubt the relationship of cause and effect, indeed, he treats it as one of the things which are "absolutely known." He believes it in spite of the fact that he is absolutely ignorant of the mechanism by which the electrical energy has been transformed into the energy of a contracting muscle. Biology has many such problems to solve, and their solution would make electro-therapeutics the most exact of medical sciences; but in the meantime I hesitate to accept Prof. Horsley's dictum that "the present employment of electricity in medicine is not known to do more than excite the tissues favourably."

W. S. Hedley.

Brighton, *March 4th*, 1895.

Water Pipes and the Frost.

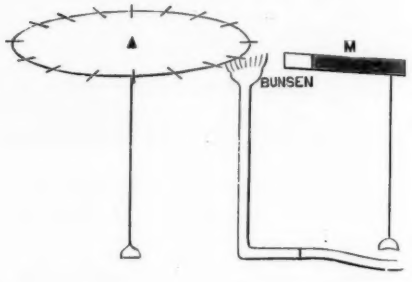
The plan mentioned by Messrs. Drake & Gorham of en closing a tube containing air in a water pipe to prevent its bursting with frost is not altogether novel, although the employment of the air tube in combination with electrical thawing is doubtless new and patentable. Fifteen or sixteen years ago, when Mr. C. V. Boys and I were making some experiments on the freezing of elliptical water pipes (the results of which were subsequently communicated to the Physical Society), a correspondent to a daily paper—the *Times*, I believe—suggested the plan of enclosing an India-rubber tube filled with air in exposed water pipes to prevent the latter from bursting with frost.

The combination proposed by Messrs. Drake & Gorham, if it can be tolerably easily applied, and if it does not get out of order, should prove to be valuable; but it seems to me that the very effectual method which is being increasingly adopted of laying hot and cold water pipes side by side is, after all, the best and most comfortable.

Legh S. Powell.

Thermo-Electric Motors.

I have to-day seen the interesting account in your issue of February 22nd of a thermo-electric motor. It casually appears to resemble what is actually a very different contrivance which I have recently invented, and the coincidence is so curious that you may think it worth while to describe this device of mine also. I made a disc of mica with thin radiating iron wires attached; the whole, supported by means of a cap in the centre, revolves on a needle. A magnet is placed near it, as shown (M), and a Bunsen burner placed



underneath the circumference makes three of the wires red hot; the magnet, when properly adjusted, draws round the nearest of the *unheated* wires attracting it just into the flame. It is at once freed from the control of the magnet by becoming red hot. The next spoke is in turn drawn to the flame, and goes through the same process, and thus the wheel continually revolves. There is no new principle involved in the contrivance, of course, and it may have been made before, though I have never met with it anywhere.

Charles E. Benham.

Niagara Dynamo.

I have been much interested in reading the letter from Mr. Atkinson about the dynamo invented by himself and Mr. Ravenshaw, and also in reading their specification. I most thoroughly appreciate the good points of their design; but the fact that there are no external revolving fields, but only revolving keepers, differentiates it entirely from the Niagara dynamos. I know that the American Patent Office made a thorough search for anticipations before granting the patent, so that, so far as present evidence goes, it appears that the design of these dynamos is novel.

I would wish, however, to take this opportunity of saying that I have had no desire to introduce novelties at Niagara, or do anything except to secure the very best arrangement of machinery that was possible.

George Forbes.

The Compiling of Catalogues.

We notice a letter in your issue of the 1st inst. under the above heading, evidently referring to our catalogue which you lately noticed. Our attention is particularly directed towards the last sentence of this letter, as to copying original designs of other makers.

Mr. Paul has apparently forgotten the old saying advising people what not to do when living in glass houses. We have before us a list of his manufactures (List No. 5), in which we find but three illustrations besides those of the galvanometers he refers to. Two of these, Nos. 5 and 6, are practically copies of our original designs, and will be found in our catalogue of a quarter of a century ago; whilst the third, No. 4, bears a wonderful family likeness to an illustration

given in a catalogue published many years ago by M. Carpentier, of Paris. For our own part we make no objection, believing imitation to be the sincerest form of flattery.

Elliott Brothers.

Windmills for Electrical Experiments.

I venture to send you photographs of a windmill which I have put up for electrical experiments in case it may interest any of your readers. It is very simple and cheap to construct, and does not race with a light load in a high wind. You will observe that three feet of the end of each arm, which is of angle iron, is bent outwards at right angles to the arm, and each sail is stretched from the extremity of one arm to the shoulder of the next, this gives the necessary angle—the other point of each triangular arm is fastened to the ring

Front View.

which supports the arms, and at each of these points is arranged for safety in case of a hurricane, a split ring which opens at a given pressure and releases that point of the sail, which then furls itself round its supporting wire. The horizontal wheel drives a dynamo, and a friction clutch is used to prevent the possibility of reversals. The nut which carries the arms revolves on a fixed axle which carries the steering tail.

W. J. S. Barber-Starkey.

Electric Refrigerator.

It is said that an apparatus, based on the well-known "Peltier's effect," has been constructed for the manufacture of artificial ice, 10 tons daily, by means of an electric current of low pressure. Is the statement true? I know that a drop of water could be easily frozen in this manner; but I do not know how to freeze, say, a bucket full with water.

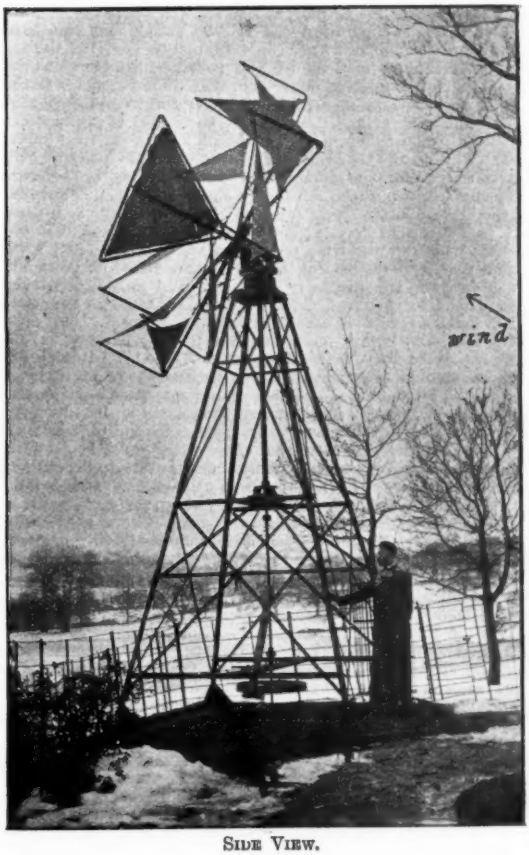
Is the apparatus a subject of a patent? If yes, will some one kindly inform me the date and number of the specification?

Doubtful Thomas.

We regret that owing to pressure upon our space this week, and the late arrival of some correspondence, we are compelled to hold over the following letters for our next week's issue:—"Niagara Dynamos," by C. E. L. Brown (Brown, Boveri & Co.); "Private and Public Supply," by Wm. Durtnall.

THE HEILMANN LOCOMOTIVE.

Mr. H. Ward Leonard is enamoured of the Heilmann locomotive which he has seen in France, and has written a paper upon it, and is convinced it has an immediate future. His chief reason for thinking so appears to be that the boiler can be made very large and the rate of coal combustion per square foot of grate can be reduced below 200 lbs. per hour. It may be that in American practice this rate is nearly touched, and that a locomotive horse-power in America costs about double as much in coal as does a stationary horse-power.



Side View.

Mr. Leonard intended to say, we think, that the evaporative duty of the boiler was only half that of the stationary boiler. But we might point out that a Great Northern express engine, hauling a train of about the same weight as America's crack train—in fact a trifle heavier—burns probably 25 lbs. of coal per mile at 60 miles per hour. As the firegrate area is about 20 square feet, this amounts to about 75 lbs. per square foot per hour.

Mr. Ward Leonard makes a great deal more out of the questions of wire drawing of the steam and the hammer blow due to counterweight action, but before making so much of these points he should first tell American locomotive engineers that they ought to use larger wheels—as they are tardily beginning to do after holding back for years, simply because they hated to copy the Britisher. He might also ask them to reduce the excessive counterweight action by putting more design and less crude weight into their reciprocating details generally. If the steam locomotive were made as big and long as the Heilmann engine, it might have an equally large boiler were this necessary. We see nothing in any reason so far advanced to warrant the principle of the Heilmann engine.

Mr. Leonard has been successful in getting a method of his own for controlling the motor applied on the large Heilmann engines now under construction, and to be of 1,500 H.P. each. His device varies the voltage in proportion to the speed required, and the current according to the desired torque, and he claims to do this without sparking.

He looks to a 1,500 Heilmann locomotive costing £6,000 and pulling 50 per cent. more load at 50 per cent. greater speed than an ordinary locomotive; but the sting of the paper comes in the tail

It would, he says, cost nearly a million dollars to try the experiment of operating an electric locomotive of 1,500 H.P. from a central station. The Heilmann type engine can be tried for 50,000 dollars, and if it prove successful—but is there any reason to doubt the facts of electric traction? Electric traction is a proved success on short lines, and 50 Heilmann engines would not give us any information as to the suitability of a pick up current on a main line of railway.

The Heilmann engine has one point of superiority. It can be worked at full power and full speed so far as regards the steam engine when going uphill. The ordinary locomotive must slow down when going up a hill, and thereby lose power just when it most needs it. But whether this one advantage is a sufficient counterbalance of the fearsome cumbrousness of this travelling central station must be answered by everyone for himself. It might do on the Righi or up Mount Pilatus, or Pikes Peak, but scarcely, we think, on an ordinarily constructed line.

CITY AND GUILDS OF LONDON INSTITUTE.

The report regarding the working of the Central Technical College, Exhibition Road, S.W., during the 1893-94 session, has just been issued, and is very interesting reading. Though the number of candidates presenting themselves at the entrance examination has decreased, the number of students admitted to the school was the same as in the previous session, showing the better preparation of students. The cause of the decrease in the number of applications for admission to the college is an important and interesting point; it is ascribed in part to the great strides that are taking place all over London in the provision of opportunities for the study of technical subjects, and practice in the laboratory and workshop. As to what extent this "competition" will injure the Central Technical Institution, it is difficult to foresee, but we do not anticipate that the Institution, with its world-wide reputation and brilliant record, will suffer in a very large degree, for the past experience of the City and Guilds professors, the extensive and complete laboratories and workshops open for practice, afford such opportunities as are not to be met in many technical colleges throughout the world. The most powerful testimony which could be paid to the efficiency of the teaching is contained in a table which gives a note of the careers of some of the students who have left the Central Technical College. There is stated the date of entry, date of diploma, distinction gained, and appointments secured upon leaving the schools or subsequently. We may mention a few, some of whose names are not unknown to our readers. Mr. A. Chatterton, who entered the school in January, 1885, now has an appointment at Madras College of Engineering as professor of engineering; H. Crompton, who entered at the same date, is professor of chemistry at Bedford College for Ladies; H. A. Humphrey, who entered later the same year, is now engineering manager to Messrs. Brunner, Mond & Co.; A. E. Rossiter, entered January, 1885, is now assistant electrician to the London County Council; Dr. W. E. Sumpner also entered in 1885, and after gaining several medals and scholarships was appointed demonstrator at the Central Technical College, then he became head of the electrical department at Battersea Polytechnic, and is at present Principal of the Birmingham Municipal Technical College; A. H. Dykes, entered 1885, lately electrician to Messrs. Latimer Clark, Muirhead & Co., also instructor in electrical engineering at the Goldsmiths' Institute; W. M. Heller, entered 1885, formerly lecturer in science at King's College School, now science instructor to the London School Board; M. H. Kilgour, entered October, 1885, now electrical engineer to Cheltenham Corporation; O. G. Jones entered October, 1886, science master at the City of London School, also lecturer at the Goldsmiths' Institute; C. G. Lamb entered October, 1886, now demonstrator in the engineering department at Cambridge University; Miss L. E. Walter, entered October, 1886, now science mistress at the Central Foundation School, Bishopsgate; J. F. Taylor, entered October, 1888, now Principal of Newhaven Grammar School; B. B. Turner, entered October, 1888, now lecturer on chemistry at the Borough Road Polytechnic; R. L. Jenks, entered October, 1889, now assistant in the Research Laboratory, Imperial Institute; G. D. A. Parr, entered October, 1889, now demonstrator in the electrical department of the Currie Technical Schools, Folkestone. We have selected only a few from a very lengthy list of more or less important engagements which have been secured by old students. We think this is a most splendid showing. There have been several changes in the Physical Department Staff, Dr. Sumpner's vacant position being occupied by Mr. W. G. Rhodes, and Mr. A. H. Allen has been appointed assistant demonstrator in the place of Mr. P. G. Ledger.

THE FATAL ACCIDENT AT BRISTOL.

On Tuesday morning, Major P. Cardew, electrical adviser to the Board of Trade, held an inquiry into the Bristol fatality. It will be remembered that the deceased, Robert Coleman (36), was an experienced workman of the Corporation Electrical Department, and was entrusted with the dusting of the apparatus in the fifteen substations in which transformers are placed. He met with his death by receiving from a 2,000 volt main a shock which passed through his body to the earth. Major Cardew first took evidence at the Grand Jury Room of the Guildhall, where the chairman of the Electrical Committee, Mr. George Pearson, and the Town Clerk of Bristol, were present.

Mr. Wilcocks, an improver connected with the civic electrical department, described the accident. The deceased was dusting a fuse board, rising from which were the slotted terminals between which the fuses formed, so to speak, bridges. He had an India-rubber glove on the right hand, but took the opposite end of the duster in his ungloved left hand and worked the cloth to and fro in the slot. As he did this he touched the terminal with his left knuckles, there was a "sizzling" noise, and the poor fellow was drawn rigidly upon his toes and against the fuse board. Efforts to restore life were unavailing. Mr. Wilcocks said he was certain that only one terminal was touched. The deceased was not wearing special boots. After hearing statements as to the experience the man had had and the medical witnesses, Major Cardew went to the transforming room in which the fatality occurred. It is approached from the street by a cellar flap accessible only to Corporation officials. It is a very long cellar, between five and six feet in width, and in heighth to the crown of the arch about 6 feet 8 inches. Two transformers, a vertical low pressure board and a high pressure board are fixed in it, the last named being furthest from the road. The cellar has a cement floor with here and there traces of absorbed moisture. The high tension fuse board stands horizontally on a pedestal built of unglazed red bricks, and is insulated on glazed ware supports standing in oil in glazed ware cups. The four terminals project vertically on opposite sides of the board, and the fuses which connect them are removable by white china handles. A metal attachment to each terminal projects beyond the edge of the board, and the brass terminal is also bare of insulation above the board.

Major Cardew made a number of suggestions as to what might be done to add to the safety of the place. He called attention to the fact that there was abundance of room—a part of the length of the cellar was vacant—and asked if a second fuse board could not be fixed, so as to have no current passing over the one being cleaned.

Mr. Faraday Proctor, the engineer to the electrical department, replied that there might be danger in the switch, but the inspector said that it could be supplied with an insulated handle. Mr. Faraday Proctor said the whole thing at present was very simple, and all the man had to do was to flick the dust off with his cloth. If it was desired the men could be supplied with two India-rubber gloves; they were at present told to work with one hand.

Major Cardew said he should not care to work with one glove in the place. He suggested that India-rubber boots would be an additional precaution. The terminals and adjustments were very exposed, and he recommended they should have placed around them a guard of vulcanite, substantially made, but shaped so as not to interfere with the dusting of the fuse board. He would also have the terminal and the metal adjustment painted red. Mr. Faraday Proctor made a note of the recommendations and Major Cardew added a suggestion that the floor should be covered with asphalte—say an inch—and the red brick pedestal supporting the fuse board (glazed bricks would have been better, said the Major) be enamelled with a non-conducting material. He asked if a smell of gas was ever noticed in a transforming room.

Mr. Faraday Proctor said it had been in one room on one occasion.

The Inspector remarked that that raised another question.

Mr. Faraday Proctor replied that the smell was very slight, and it was at once attended to. The cellar in which they were was ventilated by a grating in the cellar flap. There was no gas that could come through into the cellar very well.

The Inspector believed it quite possible it could leak through the rough masonry of the cellar.

Mr. Proctor said in that case it would escape through the ventilator. Mr. Proctor noted the suggestions, and afterwards accompanied the inspector to the central lighting station.

LEGAL.

Ross & Sons *v.* The Medical Electrical Institution, Limited.

In the Chancery Division of the High Court of Justice on Saturday, the 2nd inst., an action was brought by the holders of first and second debentures in the defendant company for the enforcement of their security against all the property and undertaking of the company, which, according to the terms of the debentures, were realisable by the holders of the debentures if the company became insolvent, or a judgment was recovered against them. A judgment had been recovered, and the company was insolvent, and the plaintiffs therefore asked for a decree.

Mr. Justice North made the order as asked, and directed a sale.

Incandescent Electric Lamp Company, Limited, *v.* Brush Electrical Engineering Company, Limited.

In the Queen's Bench Division of the High Court of Justice, on Friday, the 1st inst., before Mr. Justice Wright, this was an action by the plaintiffs to recover damages from the defendants for an alleged breach of a covenant contained in a demise of premises from the defendants at Brook Green, Shepherd's Bush. The case for the plaintiffs was that there was in the demise a covenant for quiet enjoyment, and that the lessees of certain adjoining property by their clerks made use of a strip of the demised land. Judgment was given for the defendants.

BUSINESS NOTICES, &c.

Now Ready.—The Universal Electrical Directory. This directory, which is now on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter. Price 4s.

Aberdeen.—Forty-five applications were received for the post of electrical engineer to the Corporation. Mr. Blackman, who has been in the Council's employ for some time past, has secured the appointment.

Belfast.—At the meeting of the Electric Committee the other day the electrical engineer reported on the continued receipt of applications for current, and the general working of the undertaking.

Bowness.—The Lighting Committee recently visited the works of the Electric Lighting Company for the purpose of comparing the difference between the consumption of gas, and the quantity of electric current required. It is estimated that current at 6d. per unit will be equal to gas at 5s. per 1,000.

Bradford.—A special meeting of the Gas and Electricity Committee was held on 5th inst. to decide as to the suggested extension of the electricity works, and the purchase of land in Valley Road as a site for the new works.

Brighton.—The Lighting Committee consider the time has arrived for a reduction in the charges for current, and propose that from the 1st of January last the charge shall be 7d. per unit for one hour per lamp per day instead of two hours, and for all over one hour 3d. per unit instead of 3½d. The meter rent is to be 2s. 6d. per quarter instead of 5s.

Bristol.—There is a desire to light the Lunatic Asylum by electricity, and a committee recently visited Exeter Asylum to inspect the installation there. Further consideration of the matter is now to be entered upon.

Cheltenham.—It is stated that during the present month current will be turned on by the contractors, who will run the plant on their own responsibility for four weeks, and by the middle of April it will be in the possession of the Corporation.

Derby.—The total expenditure so far upon the electric lighting works has been £34,000, and in addition there are liabilities amounting to £9,000. This is £8,000 in excess of the amount for which a loan was authorised. Messrs. Bramwell and Harris have reported to the Electric Lighting Committee regarding the extra expenditure. Upon contract No. 1, boilers, there was an excess of £211; contract No. 2, machinery, an excess of £450; contract No. 3, building station, &c., an excess of £400; contract No. 4, mains, was let to Messrs. Siemens, and it is upon this item that the greater portion of the extra expenditure was incurred, but this the engineers state cannot be regarded as extra, inasmuch as it is for work and material beyond what was originally contemplated. A table is appended to the report illustrating the increase in this contract. When the original estimate was prepared, it was contemplated that a period of two years would elapse from the date of opening before the largest output would be realised, but, as a matter of fact, this period arrived at the end of 15 months. From this table it appears that the greater portion of the extra expenditure was owing to the abnormally rapid and unexpected increase of the rate at which the public had taken the light, and the original estimate provided for a station with a capacity of 7,500 8-C.P. lamps for private lighting, and 45 public arc lamps lighting 2¼ miles length of streets, whereas the actual capacity of the station now is 15,000 8-C.P. lamps and 77 public arc lamps, lighting 4½th miles of streets. The following expenditure has been incurred irrespective of the above-named contracts:—Covering steam pipes, £134 11s. 6d.; meters, &c., £556 11s. 8d. There are at present 10,012 lamps on the private supply, and a further 2,000 are ready to be connected. By October next (the end of the two years originally contemplated) the total present capacity of the station will be absorbed. Messrs. Bramwell and Harris have advised the further expenditure of £5,000, made up as under:—Alteration of premises adjoining station, £1,000; additional distributing and connecting mains, £2,000; three additional boilers, £2,000. The committee advise the council to approve the expenditure of £8,000 over and above the amount already voted, and also to vote a further sum of £5,000 as above stated.

Doncaster.—Inquiries have been made as to the cost of lighting the parish church. It is found that the electric light plant will cost £474.

Fareham.—At the meeting of the Fareham District Council on Friday, a letter was read from Mr. G. Whitlock, solicitor to the Fareham Electric Light Company, Limited, in respect to the refusal of the council to ratify the decision of the late local board to purchase the undertaking. Mr. Whitlock wrote:—"In the hope that even now it may not be too late to repair the mischief and avert the litigation which a continuance of the council's present intention will render inevitable, I am instructed to point out that my clients' rights rest, not upon any supposed wishes of the electors, but upon an express and binding contract of sale, and at the same time to call upon the council to carry out that contract without avoidable delay." After discussion, the matter was deferred for further consideration.

Heanor.—Messrs. Fletcher & Sons installed the electric light at their Heanor lace factory. The dynamo is driven by a 30 H.P. engine, which drives the lace machines as well. The dynamo is low speed, and for 200 lights. The installation is the work of Messrs. Thomas Danks & Co., Limited, of Nottingham. The offices, drafting-rooms, and engine-house are lighted by lamps of 16 and 32 C.P., and the lace machines have two 32-C.P. lamps. Portable lights are also used, hung at the back of the machinery, when tying in warps or beams.

Kendal.—The result of the canvass made by circular as to the likely number of customers for electric current, was as follows:—64 affirmative and 254 negative replies, 141 not filled in, 49 not returned. The probable number of lamps required of various C.Ps. is 590.

Maidstone.—At the last meeting of the District Council the Electric Lighting Committee reported that they had had an interview with Mr. Thomas King, who was anxious to negotiate with the Council for the transfer of their electric lighting order, and the committee recommended that he be requested to send in full particulars of his scheme for the Council's consideration. The report was adopted.

Monmouth.—The Town Council on Monday considered the plans, &c., for a combined scheme for drainage and electric light, prepared by Messrs. Bramwell & Harris, and Mr. Lailey, C.E. The council had already gone into the plans in conjunction with the engineers, in committee, on February 22nd, and an addition of about £4,000 to the cost of the scheme was proposed, owing to additional details in the drainage of the streets of the town (Mr. Lailey's portion of the work), which would raise the original estimated cost of £18,000 to £22,000. Mr. Cossens proposed that that portion of the scheme which related to the electric light be relinquished. The Mayor stated that they would effect a saving of 5d. in the £ to the rates by the earnings of the electric light if adopted. Messrs. Bramwell and Harris had now offered to take over that part of the scheme entrusted to Mr. Lailey, and carry out the whole work at the original cost of £18,000. Mr. Cossens withdrew his proposition, and it was decided to accept the plans of Messrs. Bramwell & Harris, subject to the approval of the Local Government Board.

Rhondda.—A deputation from the Rhondda Valley Chamber of Trade visited the Urban District Council the other day with reference to the proposal to light the public streets of the Rhondda with the electric light. One of the deputation said the Chamber had decided to offer a premium of £50 for a scheme to light the Valley with electricity, but they thought it better to approach the Council first.

Worcester.—The report of the Electricity Committee regarding the "extras" connected with the electric light works has been presented. The extras seem to have been incurred without the knowledge of the committee by the city engineer sanctioning certain works. Since going into the matter the committee have received another claim from the contractor (Mr. Rowbotham) for £1,068 for damages to his works through flood.

Bankruptcy Proceedings.—The first deliverance in Browning & Gardner, electrical engineers, of 122, George Street, Edinburgh, is dated February 26th. A meeting to elect trustee and commissioners was held on Wednesday at Edinburgh.

At the Liverpool Bankruptcy Court last week J. Barnacle attended for further public examination. He had traded in South John Street as an electrical engineer, under the style of A. Hall & Co. The Official Receiver, after hearing statements, said the case was a very bad one, and if there was any further difficulty he would apply to the judge. The matter was then adjourned to March 11th.

Change of Address.—We are informed that the offices of Froggatt's Electric Lighting Company in future will be 2, Lorrimore Street, Walworth, S.E.

City Printing Works Lighted by Electricity.—The fine new printing works of the Geraldine Press, Limited, 21, Whitefriars Street, Fleet Street, E.C., and also the block of offices belonging to *Answers*, Limited, 24, Tudor Street, E.C., formerly lighted by gas, are now lighted throughout by electricity. Mr. E. R. Dolby, A.M.I.C.E., of 8, Princes Street, Westminster, acted as consulting engineer for the proprietors. The current is produced in the basement of the works of the Geraldine Press, Limited, by a compound wound direct current dynamo, built by Messrs. Crompton & Co., and driven direct by an engine made by Messrs. Belliss & Co., of Birmingham. About 190 lamps have been installed in the works, and about 80 lamps in Tudor Street, and the lighting of both premises is controlled from one switchboard fixed close to the dynamo. The large Hoe machine used for printing *Answers*, and also the Marinoni machines used for printing the large number of other papers published at the same offices, are lighted up internally by incandescent lamps, which much facilitate work. The wiring of the buildings was carried out by the Electrical and General Engineering Company, of 86, Leadenhall Street, E.C., under the supervision of the consulting engineer.

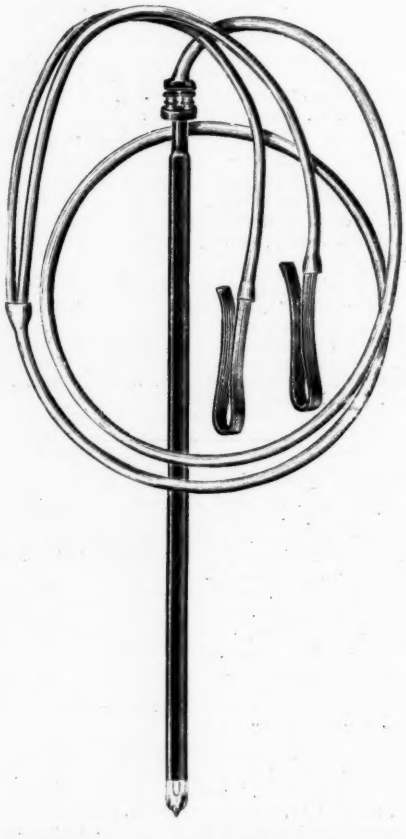
Claim for Heavy Damages in America.—A tin roofer has claimed $50,000 damages from the receiver of the Thomson-Houston Electric Company for damages caused by a defectively insulated electric wire belonging to the company burning him in many places, while he was engaged at work on a New York building.

Electric Construction Company, Limited.—From what we have seen in times past, we have somehow got into the way of expecting excellent price lists and catalogues from this company. Some of their publications have been really beautifully got up, with exquisite illustrations, and we are, therefore, sorry to receive from them a pamphlet containing a description of their works, which we cannot help saying is about as bad as anything that has been placed before us. The letterpress is fair, both as regards printing and interest, but the number of full page blocks which are intended to show the various shops and departments at Wolverhampton, either were bad originally, or have been mercilessly mutilated in the process of printing. The subject-matter is an account of a visit to the works of the company by a representative of the *Machinery Market*, from the columns of which journal the pamphlet is a reprint. It is interestingly written, and gives a general idea of the works and the business carried on there, at the same time including details of the Liverpool overhead railway, South Staffordshire tramways and Oxford electric lighting system. We certainly consider the pamphlet absolutely unworthy of the important company from which it has come.

Fire.—The Theatre Royal at Glasgow, which was destroyed by fire on Friday evening last, was fitted with both electric light and gas.

Ford-Lloyd Manufacturing Company, Limited.—In the High Court of Justice, on Wednesday, on the petition of Arthur Grove, Mr. Justice Vaughan Williams made a compulsory order winding up this company. The debt of the petitioning creditor was £300.

New Examining Lamp.—The Electrical Power Storage Company, Limited, are introducing a new examining lamp for putting into the electrolyte between the plates of their batteries. It is



especially useful for inspecting the condition of the plates that cannot otherwise be easily seen in lead or lead lined boxes. It has flexible connections, and is fitted with springs to grip on to the lead connecting bars of adjacent cells, a 4-volt lamp being used.

Presentation.—A massive Queen Anne salver, in solid silver, has just been presented to Mr. Harold W. Kolle, on the occasion of his resigning his appointment as head of the staff of Messrs. S. Z. de Ferranti, Limited. Mr. Ferranti, in publicly making the presentation on behalf of the directors and employés of the firm, expressed the sincere regret of them all at losing Mr. Kolle, and their heartiest good wishes for his very successful and prosperous future career. The inscription testifies that the salver was presented to Mr. Kolle "by the directors and employés of S. Z. de Ferranti, Limited, as a mark of the esteem and respect in which he has been held by them during the last seven years," and is a very handsome piece of workmanship. Mr. Kolle, who has accepted an engagement with the Babcock & Wilcox Co., is an old "stager" in the electric lighting world, being on the staff of the original Ferranti Co. in 1883, and manager of the Eastbourne Company from 1885 to 1888, during which time he converted the system of supply from the old parallel series system to the present 2,000-volt alternating current. Since 1888, when he returned to London to rejoin Mr. Ferranti, Mr. Kolle has assisted in all the work undertaken by the firm, including the Grosvenor and Deptford stations of the London Electric, and in the general central station and engineering work undertaken by Mr. Ferranti at home and abroad. We wish Mr. Kolle every success in his new work.

Personal.—Mr. F. B. Lea has been appointed resident engineer in Rouen during the conversion of the tramway system from horse to electric traction. His address in Rouen (probably for the remainder of this year) will be 2, Rue de la Republique. Any communications sent to him there, or in London, to Suffolk House, E.C., will have attention.

The "Standard" Safety Candle Fittings.—The imitation candles which formed a really ornamental method of utilising the old fashioned chandeliers, have not been much used owing to their excessive cost, but a new era has commenced. Conical incandescent lamps can now be obtained at a price little if at all above that of the ordinary 16 C.P. standard, and, as a consequence, they are coming more and more into vogue. For this to happen without inconvenient short circuits, &c., necessitated improvements in the methods of fixing and connecting up, and it is one of these improvements which we now illustrate, which has been patented by Messrs. Mellier & Lowry. In the older style of candle fitting the inner brass tube was supposed to be kept rigid by rubber rings fixed round it, but more often than not they were too small for the opal tube, and consequently had a loose appearance. In addition, the inner brass tube, being small, was used as the return circuit with only one leading-in wire, not at all a safe arrangement. Fig. 1 shows the

Fig. 1.

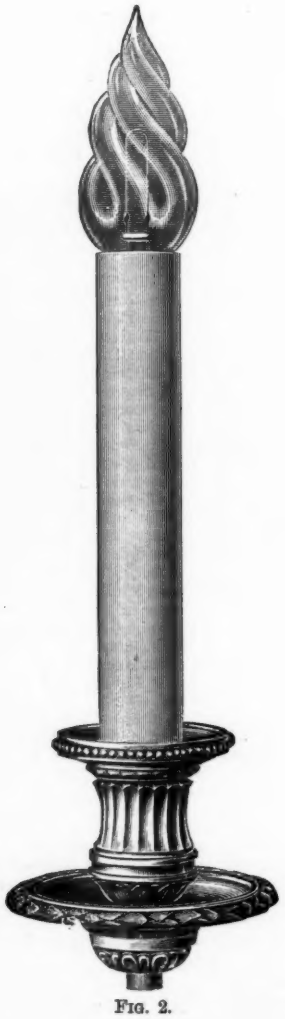
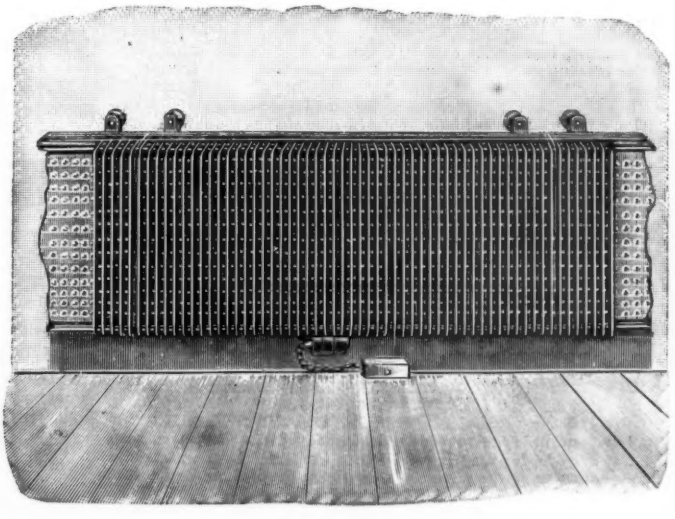


Fig. 2.

new patent, in which it will be seen that a perfect fit is obtained in any size opal tube by means of the upper and lower metal springs, which can be bent in or out as desired, while the thickness of the rubber ring at the base is also adjustable by means of the small nut above it. The inner tube is of sufficient capacity to admit two leading wires which can run right up to the holder. This also is small enough to slip in to the opal tube and yet will screw on to the brass tube, and of course can either be Edison screw or bayonet joint as required. The sole supplier is Mr. T. G. Poole.

The Electric Heating at the Vaudeville.—The authorities at the Vaudeville Theatre found it necessary to provide some system of warming, and, after considering the usual methods, they came to the conclusion that electricity offered advantages over all others. A trial was made with four large radiators of the "Crompton-Dowsing" type, taking 12 ampères, with a total of 36 square feet of heating surface. These radiators were connected with the lighting circuit, and placed in the best positions for warming the more important parts of the theatre. A week's trial showed excellent results, and it was evident that with more heating surface sufficient heat could be obtained for all requirements. An order was, therefore, placed with Messrs. Crompton & Co., Limited, for the supply of electric radiators to be fixed around the skirtings on either side and along the front of the orchestra. These radiators are of "box" or "wall" form, that is, they have a front radiating surface studded with projections fixed into cast-iron boxes which are screwed by means of lugs and insulators to the walls and partition. Each box radiator is 2 feet long and 1 foot wide, and, therefore, offers a radiating surface of 2 square feet. The air is allowed to circulate between the casing and the wall, so that an extra heating surface is obtained. There are six box radiators on either side of the theatre, and 12 attached to the partition in front of the orchestra. The latter are cased in at the back, and a good current of air is obtained by carrying the casing below the boxes containing the radiators. The four large portable radiators originally on trial are arranged for use, either in the stalls or at the sides. Four wall sockets are fixed, two on each side, and four on the chair supports in the centre of the stalls. By means of these connectors the radiators may be employed to warm the centre before the performance begins and afterwards removed to the sides. Each radiator, portable and fixed, has a patent safety connector, and can be detached from the circuit at will. The radiators reach the usual temperature of hot water pipes, and they are found to produce quite sufficient heat. The average temperature of the theatre inside after the radiators have been working a reasonable time is about 60° (*i.e.*, temperate) when the corridors are about 40°. Most theatres are subject to draughts from the frequent opening of doors and from the stage, but notwithstanding these the temperature at the Vaudeville is maintained fairly constant. Arrangements have now been made for warming the stage, and no doubt this will prevent the passage of the cold currents of air usually experienced when the curtain is raised. The current taken by each large portable radiator is 12 ampères, and the small box radiators take 3 ampères each, making in all a total of 114 ampères, but as only two of the larger radiators are found necessary the current actually used for warming the auditorium is 90 ampères at 100 volts. Thus it will be seen that 9 units per hour are required when the whole apparatus is in full work, and the cost at 4d. per unit is 3s. per hour. To warm the theatre, therefore, for a period of four hours the cost is 12s. One distinct advantage makes electric heating far preferable to other systems, and that is the perfect regulation. Thus the whole or any number of the electric radiators may be put on or cut off at will, and there is no fear of overheating the theatre and making it uncomfortable at any time. No attention whatever is required with the electrical radiators, and any of the theatre attendants can turn the current on or off according to the requirements of the case. Owing to the fact that the radiators have not to be turned on until a short time before the performance begins, the state of the weather may be judged and the heat graduated accordingly. In comparing the up-keep of the electrical plant with hot water systems Messrs. Crompton state that the former will in all probability be considerably less than the latter, owing to the fact that there is no furnace to burn out, and no rusting or wearing out during long periods of disuse. Electric radiators are found to be very durable, they are not required to reach high temperatures, and they offer a large radiating surface. Electric radiators are so constructed that they cannot overheat themselves, they radiate the heat as freely as it is produced, and, as a consequence, may be left to work without attention and in perfect safety. The installation at the Vaudeville has been carried out with the greatest care. Henley's cables of high insulation are used, and the switches, cut-outs, safety connectors, &c., are of the latest and best type. This being a pioneer installation some difficulties were at first experienced with regard to the insurance rules, none of which were applicable to the special circumstances of the case. Mr. Musgrave Heaphy, of the Phœnix Fire Office, who had to pass this work, has now drafted out a set of rules with regard to electric heating which will be applicable to all work of the kind in future. The cost of installing the electric heating apparatus at the Vaudeville has come out at about the same as for hot water heating, and, taking all into consideration, the electric system of heating offers many advantages over the older forms of heating employed, which would justify even a higher price. It may be stated that electric radiators are on trial at several other theatres and public buildings, and in many places where other systems of heating are in use it is proposed to employ these radiators for temporary assistance in extra cold weather, or for use at a moment's notice when no provision has been made for warming the building in the usual manner. Cold corners of rooms, bath rooms, and other places, may now be warmed where many systems of heating are entirely barred on account of danger in their use. It is proposed to use electric heating in churches, and electric foot warmers have been suggested. The latter were to be used at the Vaudeville Theatre, but the time required for supplying and fixing them would have taken too long. Altogether there appears to be a field for the use of electricity for heating purposes.

Portable Radiators.



Box Radiator.

Leeds Tramways.—The Leeds City Engineer (Mr. Hewson), has submitted a report to the Corporation, in which he compares the cost between the present system of haulage, the cable, and the electric system of traction. *The Contract Journal* states that he takes first the capital, and secondly the annual sum each would require, remarking, however, that his estimates do not include the use of the spare heat at the refuse destructors, his reason for this being that, even supposing the whole cost of fuel could be saved by utilising this heat, the saving would be less than the gain from having the overhead electric generating system at one central station, or the cable system at a minimum number of stations, all being placed in the best situation for coal, water, and economical working. With respect to the present system, he finds that the total first cost, and the cost of remodelling the existing tramways, including buildings and improved equipment up to 7½ minutes' service, would be £265,884. As to cable, his estimate is £428,922. For the overhead electric system, the estimate is £378,499. The total annual cost of working the present system he puts down at £117,292; of the cable at £101,819; and of the overhead electric system at £90,072. The difference in favour of the overhead electric system over the cable system is, therefore, £50,423 in capital account, and £11,747 in annual cost. As the number of cars and service in each of the systems would be alike, the income on each of the systems would be exactly the same. Mr. Hewson remarks that whilst it is true that the cable cars with a certain frequency of service beat the electric overhead in point of cost, excepting in towns having more severe gradients, and a longer length of them than there are in Leeds, this feature has been greatly exaggerated. It has been suggested to Mr. Hewson—and until going into figures he thought such an arrangement might be feasible—that the centre of the city should be worked by cable system and the outskirts by electricity, but from figures he has given it will be seen that the cable system, with its necessarily quick service and the traffic needful to warrant such a service, would be so limited in length as to render such a suggestion not practicable. Comparing the advantages of the two systems, continues the report, even ignoring finance, it appears, putting it broadly, that if it were not for the objectionable appearance which the poles and wires of the electric overhead system lends to the streets and the weight of the car, that system would be practically in all respects superior to the cable. In regard to the weight of the car, it is only 6¼ tons, and not 9½ tons, as is

generally stated, and the weight of those now being made is only five tons, whilst the weight of the present bogie cars drawn by steam engines is 4½ tons, thus leaving little to be complained of in this respect. A great improvement can be made in regard to the poles and wires also. All the wires running along the footpath should be laid underground, and all the poles placed against the buildings, or when the width of the streets will permit, ornamental posts carrying arc lights should be placed in their stead in the centre of the roadway. With these improvements, and remembering that electric traction has a wider field for improvement than cable, he is of opinion that the overhead electric system of haulage is certainly the cheapest and the best system for the city of Leeds.

New Firm.—Messrs. F. A. Glover & Co. have started business as electrical engineers and contractors, at 97, Queen Victoria Street, E.C. Mr. Glover was formerly with Messrs. Crompton & Co.

Ship Lighting.—The Cape liner *Johannesburg*, which has just been built by Sir Wm. Armstrong & Co., is lighted throughout with electricity. The electrical plant, which is in a corner of the engine-room, drives fans for supplying forced draught to the furnaces, as well as supplying energy to five circuits of incandescent lights.

Swinburne & Co., Limited.—Mr. Holt, late managing director, has been appointed general manager of this company, with control of its affairs as from January 1st, 1895. The company report that they are extremely busy at present, having more orders and inquiries in hand than at any previous period of their existence.

The Institution of Junior Engineers.—On Saturday, February 23rd, a very large number of the members of this Institution availed themselves of the opportunity kindly afforded by the President, Mr. Alexander Siemens, for visiting Messrs. Siemens Brothers and Co.'s manufactory, at Woolwich. Special arrangements had been made for their guidance over the extensive works which cover an area of 7½ acres, and the occasion was rendered exceedingly interesting in every way. The new and old dynamo shops, the milling, bobbin, fitters', and rubber shops; the central power and lighting station (all the machinery is driven by electric motors) the switchboard erecting room, the cable shop, tank houses, lead cable shop, cable testing, instrument calibrating, and show rooms were seen. At the conclusion of the inspection the members were hospitably received by the president, who expressed the pleasure he felt in meeting them, and the chairman, Mr. H. J. Young, conveyed the thanks of the Institution for the facilities extended in connection with the visit.

The Mersey Railway.—The report of the directors of the Mersey Railway Company states that the subject of working the railway by electricity, or other motive power, is still receiving their consideration, and they hope shortly to be able to report further upon the matter.

CONTRACTS OPEN AND CLOSED.

OPEN.

Brentford.—March 12th. Estimates are invited for supplying and fixing telephones and electric calls in connection with the fire brigade, for the Urban District Council. Forms of tender and specification of the work required to be executed, and any other information, can be obtained upon application to Mr. Nowell Parr, engineer and surveyor to the Council, Clifden House, Boston Road, Brentford.

Eccles.—March 16th. The Corporation are prepared to receive tenders for an electric light installation at their Sewage Farm Works, Peel Green Road, Patricroft. Specification of work required, and all particulars may be obtained from the engineer, Mr. H. Leonard Hinnell, A.M.I.C.E. (Hinnell and Murphy), 15, Mawdsley Street, Bolton.

France.—9th inst. The Prefect of the Seine, in Paris, is inviting tenders for the carrying out of an electric lighting installation in the Academiè de Paris (Sorbonne).

Italy.—March 14th. The municipal authorities of Gattinara (Norara) are inviting tenders for the concession for the establishment of a central station for the electric lighting of the town during a period of twenty years.

Italy.—The municipal authorities of Spezia are at present inviting proposals for the establishment of a tramway in the town to be operated either by horse or steam power or by electricity.

Killarney.—The Governors of the District Lunatic Asylum intend inviting tenders for an electric light installation for that Institution. A loan is to be applied for.

Llanelly.—March 25th. The Llanelly Borough District Council invite plans, designs, specifications, and estimate of cost of providing and fixing electrical plant and machinery, including street lamps and laying down mains for lighting certain portions of the town. The plant, machinery, and mains must be of sufficient power to provide for lighting the streets, private premises, and several large public buildings within the area. Plans of the district, showing the streets and situations of the public and private buildings, together with further particulars, can be obtained upon application to Mr. George Watkeys, C.E., borough surveyor, Llanelly.

Manchester.—March 19th. Tenders are invited for the supply during twelve months ending April 30th, 1896, of stores and materials for the Manchester, Sheffield, and Lincolnshire Railway Company:—(1) asbestos packing; (14) brass cocks; (18) copper and brass; (22) steel ferrules; (23) files; (29) brass gas and water fittings; (30) iron ditto; (31) gold leaf and bronze; (32) hardware; (33) hinges; (34) iron; (35) India-rubber cylinder springs; (36) lamp fittings; (42) oil, tar, pitch, turpentine, &c.; (43) canvas hosepipe; (55) telegraph materials; (56) sundry tools; (57) tin sheets and tin plates; (59) varnish; (61) wire. Patterns can be seen on and after 11th inst. on application to Mr. A. W. Longden, storekeeper, Junction Street Mills, of Ducie Street, London Road, Manchester. Specifications, with forms of tender, may be obtained from Mr. Oliver S. Holt, secretary, London Road Station, Manchester.

Stowmarket.—April 5th. Tenders are invited for lighting the streets of Stowmarket from August 15th next to May 15th, 1896, and also for lighting the post-office clock, for the Stowmarket Urban District Council. Particulars to be had of Mr. S. Prentice, clerk.

South Africa.—The *British and South African Export Gazette* believes that tenders are shortly to be invited by a London company for carrying out an electric lighting installation at Buluwayo. The system adopted will probably be the Elwell-Parker positive current incandescent, of 110 volts, but tenders will be received from firms representing other systems, including the alternating current system. Estimates must be based on a present want of 3,000 lights of 16-candle-power. Estimates and tenders will also be called for for the necessary number of sets, receivers, and transmitters, on the now approved London telephone methods. Messrs. C. Jefferson Clark and J. C. Verey, Buluwayo, are acting as engineers for the schemes.

CLOSED.

Birmingham.—We understand that Messrs. Thomas Parker, Limited, have obtained the contract for the electrical plant for Birmingham Technical School, to light 116 rooms by electricity. The amount of the contract is £13,226. The tenders sent in ranged from £20,510 to £13,226.

New Cross.—The Metropolitan Asylums Board have accepted the tender of Messrs. W. Seymour's Walton Metal Works, Walton Street, Chelsea, to supply and fix overhead electrical fire alarms, wires, and electric bells at the South Eastern Hospital, and maintain the complete electric bell system for three years, also additional bells at the Western Hospital, Seagrove Road, S.W.

NOTES.

The Pacific Cable.—The *Montreal Gazette* last month published figures showing the lowest tender on each of the eight routes for which tenders were invited. The offers are based on a cable capable of transmitting twelve words per minute, but other offers were also made of cables of a capacity of fifteen and eighteen words per minute at a slightly advanced cost.

Route No. 1, from Vancouver, via Fanning Island and Fiji to Norfolk Island, there to divide, one cable going to New Zealand and the other to Australia, £1,517,000.

Route No. 2, from Vancouver to Neckar Island and Fiji to Norfolk Island, there to divide, one cable going to New Zealand and the other to Australia, £1,416,000.

Route No. 3, from Vancouver via Neckar Island to an island in the Gilbert group, there to divide, one cable going by way of Fiji to New Zealand and the other by way of the Solomon Islands to Queensland, £1,303,000.

Route No. 4, from Vancouver via Neckar Island, and the Gilbert and Solomon Islands to Queensland only, £1,068,000.

Route No. 5, from Vancouver via Neckar Island, and Fiji to New Zealand only, £1,291,000.

Route No. 6. from Vancouver to Honolulu and there to divide, one cable going to New Zealand, the other to Australia, £1,391,000.

Route No. 7, from Vancouver via Honolulu, the Gilbert and Solomon Islands, to Queensland only, £1,081,000.

Route No. 8, from Vancouver via Honolulu and Fiji to New Zealand only, £1,243,000.

It will be remembered that the sums include a maintenance for three years.

Gas and Electricity in France.—Gas and electricity in France are combining to meet the requirements of lighting by either method, according to circumstances. In view of this fact, another journal has been started in the interests of both industries, entitled *Revue Gaz et Electricité*. This journal has just published a general summary, giving all particulars relating to the technical companies and syndicates of the gas industry, and to all the electrical companies. This work also gives a list of all the makers of apparatus used for either gas or electricity.

The American Pacific Cable.—The following telegram has been received from the United States:—"The Senate has withdrawn the amendment to the Diplomatic Appropriations Bill providing for a sum of $500,000 for the laying of a cable to Hawaii, thus definitely killing the project." From this it appears that for the present this project has been abandoned, as a Government work, by the Senate. We learn, however, that the scheme has been taken in hand by several prominent individuals with a view to carrying out, and extending this enterprise beyond the limits originally contemplated by Congress. The following extract from a letter written from Washington by Mr. Thurston, the Hawaiian Minister, explains the position of affairs.

The scope of the plan now proposed by Admiral Irwin and the others is to obtain from the present congress a charter of incorporation merely, without mention of subsidy or other assistance. This will enable them to proceed to negotiate with other Governments, Hawaii, Japan, Russia, and France, and ascertain what subsidies and concessions can be obtained from them, so that when the next Congress meets in regular session they will be in possession of all the necessary facts to lay before it to serve in arguments in favour of further assistance from the American Government. The plan embraces communication from California to Honolulu, thence radiatory to Japan, Australia, and to Tahiti.

The Japanese Minister here has intimated his strong desire to assist the proposition, and is communicating with his Government, urging them to grant assistance.

The French and Russian Legations have not yet been seen, but I am to see them to-day. From the fact that the French already have a cable from Australia to New Caledonia, as the direct line to Honolulu, and that the French Minister at Honolulu received information from the Hawaiian Government that such company was anxious to proceed with its cable to Honolulu; and the warm interest taken in this same proposal by the Russian Government in 1890, we believe that subsidies can be obtained from those several Governments in aid of the proposed telegraph system.

Our readers may remember that this is not the first occasion on which this matter has been brought before the American Congress; as in 1891 a Bill similar to that above indicated was almost carried, and we have little doubt that the scheme will be brought forward again next session.

Controlling the Electrical Industries of Paris.—Two years ago, the syndical chamber of the electrical industries of Paris created an office having for its object the control and the testing of the electrical installations now in service. The manager, M. Picou, has just retired, and M. G. Roux has taken his place. During the year 1894, the number of subscribers to the controlling office has risen from 52 to 82, the number of lamps subscribed for rose from 13,273 to 19,848, and the number of visits made was 210, as against 101 in 1893. The total receipts were 18,095 fr., and the total expenses 16,735 fr. The net profits were therefore 1,360 fr. This statement was accepted by the syndical chamber at the sitting of February 5th, 1895.

The Société Internationale des Electriciens.—The ordinary meeting of the Société des Electriciens took place February 6th, 1895, with M. Postel-Vinay as president. M. Farman first explained in a few words M. Hermite's electrical system of disinfection. This system is now well known; we need not, therefore, enter into it here. M. Picou then read a paper bristling with mathematical calculations on "The Conditions of the Transmission of Electrical Energy by Synchronous Alternating Motors." The writer intends to publish a detailed report of his paper in the *Bulletin* of the Society.

The Frost and the Pneumatic Tubes.—During the recent frost the proper working of the pneumatic tubes connecting the Central Telegraph Office with the various City and West End receiving and branch offices served by tube, has caused great anxiety to the postal telegraph officials. A large number of carriers have from time to time been stopped in the tubes owing to the accumulation of ice, and these have in a few cases been freed only after considerable trouble. Many of the tubes were kept open night and day, and a current of air kept flowing through them. This air, heated by compression in the pumps, has been a very great help. In the event of a carrier stopping in the tube, another carrier partly filled with salt has been sent after it. The impact causes the salt to scatter against the imprisoned carrier, and the non-freezing mixture so formed in most cases quickly sets it free.

The Practical Applications of Alternating Current Motors.—The paper on this subject, read by Mr. Fryer, A.I.E.E., before the Junior Society of Engineers, and to which we referred last week, treats of the subject in a very elementary manner and without advancing anything of novelty. If the paper proves anything, it proves the fact that alternating motors, single or polyphase, are not held in much esteem in this country; in fact, the author describes a plant which he has put down, and claims for it the distinction of being the first (and we presume the only one) working an alternating single phase motor over one horse-power in England. The treatment of the subject by this author is not likely to induce engineers to take up the matter. When we are shown the elaborate arrangements required for starting single phase motors it is not to be wondered at that most people are but little inclined to use them, and are prepared to accept the commutator as no more troublesome than the double winding, the condenser, and the armature resistances, required for working the single phase motor. Of course where motors are supplied only from alternating public supply, it is a case of Hobson's choice; the single phase motor is the only thing available in these cases. But most motors are used in isolated plants, and there the engineer is free to choose his current and motors, and if alternating current is chosen on account of its easy transformation the polyphase motor is superior in every way to the single phase. We have no doubt polyphase motors will come into very extended use in mines and in works where the distribution is extensive, but the paper read by Mr. Fryer does not enter into any details of any importance which might have enabled us to compare the efficiencies and other interesting points between the various motors upon which he touched.

Lectures.—Mr. A. P. Trotter's third lecture to the pupils and staff of Messrs. Crompton & Co., at Chelmsford, on Monday last, concluded the subject of "Royal Roads to Calculation." Sixteen different examples of slide rules straight, circular, cylindrical, gridiron, and compound, were shown, and the use of the ordinary rule was demonstrated by a slide rule 10 ft. long. Slide rules were lent for exhibition by Messrs. Elliott Brothers, Mr. J. Mactear, Mr. Ravenshaw, and others. Mr. Trotter's last lecture will be upon photometry of candle-power and of illumination.

A special course of four lectures on "Electric Light Wiring" will be delivered in the Heriot-Watt College, Glasgow, on Monday evenings, at seven o'clock, commencing on Monday, March 11th, by R. Mullineux Walmsley, D.Sc., F.R.S.E., &c., Professor of Electrical Engineering. The points considered will be those of importance to wiring contractors and to householders and others who propose to take advantage of the public supply of electric current by the corporation. Lecture 1.—Conductors and circuits; rules for safety. Lecture 2.—Positions and fixing of conductors. Lecture 3.—Switches, fuses, and other small fittings. Lecture 4.—Lampholders, brackets, and electroliers.

On Monday last, at St. Andrew's Parish-room, Fairholt Road, Stoke Newington, N., Mr. Fred H. Taylor, Assoc.I.E.E., delivered a lecture on "Recent Developments in Electrical Science." The following were some of his points:—Recent advances in electric lighting, heating and cooking by electricity, transmission of power, Niagara Falls Scheme, electric bleaching, &c., executions by electricity, electric welding, electric traction, electric signalling through space, captive balloons, electrically operated musical instruments, the microphone, the telautograph or writing telegraph, Edison's phonograph, Edison's kinetoscope. The lecture was illustrated by experiments.

At a meeting of the Bristol Insurance Institute the other day, Dr. Ernest H. Cook, F.I.C., F.C.S., delivered a lecture on "Chemical and Electrical Fire Risks."

Before the Glasgow Association of Students (Institution of Civil Engineers) last week, Mr. J. M. Munro, A.M.I.C.E., read a paper, which was illustrated by limelight views, on "Electric Tramways and District Railways."

Society of Engineers.—At a meeting held at the Westminster Palace Hotel, Westminster, on Monday evening, a paper was read by Messrs. W. Worby Beaumont, M.Inst.C.E., and Stephen Sellon, Assoc.M.Inst.C.E., on "Parliamentary Procedure as affecting Light Railways and Tramways."

The Incandescent Lamp of To-Day.—There is an article under this title in *Cassier's Magazine* by a Mr. J. H. Cuntz. A large part of it is devoted to a peculiarly poor description of the processes employed in lamp manufacture, and several inaccuracies may be detected. The article is, however, illustrated by a number of excellent engravings, several being evidently representations of the actual workshops of the Edison factory (America), and an inspection of these may be found profitable and interesting to some. As regards the filaments, "an artificial compound of carbon, the nature of which is kept a secret," has recently displaced the time honoured bamboo material. This compound is cut to the requisite lengths and thicknesses. There is a special department in the Edison factory devoted exclusively to the manufacture of decorative and special lamps of various kinds. Amongst the latter may be mentioned some 1 candle-power lamps, which are arranged to light up at night time in telephone exchanges whenever a call is received, and to remain alight until that particular call has been answered. It is stated that the principal lamp factory in the United States turns out on an average some 25,000 lamps per day.

Dissolving Power of Sulphuric Acid.—An instance of the great dissolving powers of sulphuric acid is furnished by an accident which recently occurred in a chemical factory at Mulhouse, Alsace. An operative was blown by an explosion of nitro-benzol into a large trough filled about 3 feet deep with sulphuric acid, the temperature of which, was found to be 91° C. ten hours after the accident. The death of the man in this trough was only proved by the discovery of the caoutchouc respirator, muzzle, two porcelain buttons, and other difficultly soluble articles. According to the *English Mechanic* everything else had chemically combined with the acid. Surely this would have been a splendid opportunity for a well-known gentleman in the electrical world to experiment upon the resuscitation of man by means of electro-deposition after the body has been dissolved.

Electric Lighting for Carriages.—With reference to the article which we published last week on this subject, Mr. Arthur Shippey writes stating that Mr. C. W. Chancellor, the United States Consul at Havre, in preparing his report has evidently not gone into the historical work of others relating to the electric lighting of carriages. He says that Mr. Chancellor is mistaken when he states that the Prince of Wales was the first to adopt such a system in London, and he takes to himself the honour of having as far back as 1883 lighted the carriage of Lord Mayor Knight by exactly the same method. This Mr. Shippey claims was the first carriage ever electrically lighted in England. He further complains that Mr. Chancellor's report, as it now stands, gives credit to France and Germany for the introduction of carriage electric lighting, whereas the method was invented and originally introduced by him (Mr. Shippey) in this country.

Bordeaux Exhibition, 1895.—Forms of application for space at this exhibition, which is to be open from May to November, are now ready. There will be a special building called the "Palais de L'Electricité," which will be devoted solely to electrical apparatus and machinery. The prospectus of this department, which is Section 9, group 32 (classes 123 to 130) is before us, and shows the following distribution of the various classes of exhibits:—Class 123—The study of electricity and magnetism; 124—Industrial production of electrical energy; 125—Electric lighting; 126—Electric transmission of power, and electric traction; 127—Electro-metallurgy and electro-chemistry; 128—Telegraphy, telephony, and signalling; 129—Medical electricity; 130—Various applications. The secretaries are M. A. Marton, 14, Rue des Augustins, Bordeaux, and M. Georges Vène, 15, Rue Sainte-Catherine, Bordeaux, from whom all particulars can be obtained.

North-East Coast Institution of Engineers and Shipbuilders.—On Tuesday, March 12th, the discussion on Mr. W. C. Mountain's paper on "The Design and Efficiency of Plant for the Transmission of Power by Electricity," will be concluded, and that on Mr. Henry Foster's paper on "The Application of the Electric Arc to Machinery and Boiler Repairs," will be continued.

Cardiff Electric Lighting Affairs.—Though in Cardiff the opponents of electric lighting have been unscrupulous and bitter, the Town authorities really do their best to fall into the hands of the Philistines. They have for some time past wanted an engineer to run the Corporation electric light works, and to encourage applicants of spirit and resource they have had a list of duties carefully drawn up. The document consists of 19 clauses, and the Borough Engineer figures 20 times. It would give us the greatest pleasure to publish fully this remarkable set of rules, but we must be content to give a sample:—

1. The *Borough Engineer* to be chief of the department.
2. All correspondence . . . . to be conducted by the *Borough Engineer*, and all complaints are to be directed to him.

To paraphrase two or three of the rules: All orders for plant to be issued by the *Borough Engineer*. All applications for energy to be made to the *Borough Engineer*, all reports in connection with the undertaking shall be submitted to committees by the *Borough Engineer*.

6. The engineer in charge shall in all matters act under and carry out the instructions of the *Borough Engineer*.
7. He shall under the direction of the *Borough Engineer* have the supervision and charge of the generating station, sub-station, &c., and of all the men employed . . . . and shall immediately report to the *Borough Engineer* any defects.
8. He shall keep the time of all men employed under him, and return same to the *Borough Engineer* daily.

Then for eleven more clauses we have this painful reiteration of the Borough Engineer, and the whole concludes with—He (the poor unfortunate engineer) shall in all other matters not herein mentioned act under the instructions and directions of the Borough Engineer. If any weak, boneless worm would like to run Cardiff Corporation Station under the conditions adumbrated above he will be taken on at once. He need have no special knowledge of central station practice, the less the better; his only qualification is that of being able to grovel several times a day to the Borough Engineer. Frankly, this Corporation has started too early with electric light works. It ought to have commenced with a small gas plant under the Town Hall and a small boy (under the rigid supervision of the Borough Engineer) to look after it. Such would have been good practice for the Corporation, and the Borough Engineer as the head of the electricity works would have gained experience. But seriously, who is responsible for the miserable way in which the Corporation deal with such important matters? We should not like to think that the consulting engineer has had anything to do with it. Still there must be somebody who is responsible for the ridiculous position which the Corporation occupy at the present moment, and in order that his name could be handed down to posterity, we should like to know it.

Yankee Ways.—We suppose our American friends would think us in a hurry if we dared expect the World's Fair exhibitors' awards to be delivered to the winners yet awhile. Scarcely 18 months have passed since the exhibition doors were closed, and here we have impatient British exhibitors—who were advised 12 months or more ago that they are entitled to medals and other honours—wondering when their awards are coming! We would advise them not to be in too great a hurry; they will no doubt receive their dues by the date of opening the great 1900 Paris Exhibition. Much is said of the go-ahead spirit characteristic of our trans-Atlantic friends. May we regard this as a specimen?

Institution of Civil Engineers.—On 5th inst., the following papers were read:—"Electrical Haulage at Earnock Colliery," by Mr. Robert Robertson, B.Sc., &c.; "Water-Power Applied by Electricity to Gold Dredging," by Mr. Robert Hay.

The Northern Society of Electrical Engineers.—At a meeting to be held at the University College, Liverpool, on Monday, March 11th, a paper on "The Scientific Principles of Electrical Engineering" will be read by F. G. Baily, M.A., member.

The Institution of Electrical Engineers.—On Thursday, March 14th, 1895, a paper on "The Electrolysis of Gold" will be read by N. S. Keith, member.

Junior Engineering Society.—On Saturday afternoon, March 16th, 3 p.m., the members will visit the Midland Railway's Goods Station and Depôt and repairing shops, by kind permission of S. W. Johnson, Esq., locomotive superintendent. The upper level of the Goods Station, Somers Town, is lit electrically, current being supplied from engine house on the premises, also supplying passenger station, goods depôt, and sidings. Six 25-H.P. Thomson-Houston dynamos, supply 203 arc lamps of 2,000 C.P. The steam engines, driving dynamos, have cylinders 13 inches diameter, 20 inches stroke, and run 150 revolutions per minute.

Obituary.—The death is announced of Mr. Hyde Clarke, at the age of 80 years. The *City Press* states that after following energetically and studiously various occupations, he turned his attention to engineering, and later devoted himself to telegraphic science. In 1849, he was employed to report on a system of telegraphic communication to India.

The Queen Regent of Spain and the Telephone.—During her recent illness, from which she has now almost recovered, the Queen Regent of Spain, feeling keenly the separation from her children, gave instructions for a telephone to be fitted up from her bedside to the apartments of the Palace in which they are secluded for fear of infection. By this means Her Majesty frequently conversed with her family.

"Our Full Page Plate."—*Electrical Plant* for March contains a supplement, which is an illustration of an electrical locomotive made by the Acme and Immisch Company. We do not wish to quarrel with the old locomotive, we only desire to point out that the self-same cut appeared in the Electrical Review on August 26th, 1892.

Stress and the Corrosion of Metals.—A very curious point has been investigated by Mr. T. Andrews, which may be said to have a practical bearing upon engineering of no small importance. He has investigated the influence of stress upon the corrosion of metals, with a view of determining to what extent the alteration of rate of corrosion might account for the local attack sometimes observed in metallic structures and plant. Bars of the same kinds of iron or steel were subjected to different stresses, in other respects being completely similar; they were then placed in an electrolyte, usually a solution of common salt, and the difference of potential between them taken as a measure of their relative corrodibility. A large series of experiments were conducted upon different kinds of iron and steel with results which were nearly identical, and which may be summarised as follows:—The effect of tensile stress was to cause the production of an average E.M.F. of 0·016 volt between the strained and unstrained bars, the unstrained bar or electrode being positive, and therefore considered by the author to be more corrodible. The effect of torsional strain was to produce an average E.M.F. between the electrodes of 0·018 volt, the unstrained metal being again electro-positive. Flexional strain on plates gave an average of 0·012 volt in the same direction. Flexional strain on shafts gave an average of 0·010 volt. The author draws the following conclusions:—Wrought-iron, when exposed to the corrosive action of sea water for long periods without being subjected to other causes of corrosion, than such as are local, is more resistant than steel, the difference sometimes amounting to as much as 25 per cent. The more carbon present in the steel the greater the corrosion. Galvanic corrosion, he considers, may be set up in metallic structures exposed to tidal flow by reason of the local variations of the electrolyte (sea water) in contact with them. The electromotive force existing between the strained and unstrained metal in the same structure may induce local corrosion. Further details may be found by consulting the *Proceedings* of the Institute of Civil Engineers, cxviii., 4, where the original paper is given in full.

Electrical Regulation of Steam Engines.—Before the Institution of Civil Engineers, Mr. John Richardson, M.Inst.C.E., recently read a paper on "The Mechanical and Electrical Regulation of Steam Engines." The author, in dealing with the electric regulation of engines, said the conditions which obtained for an engine driving a dynamo were not quite the same as those for maintaining a constant speed of other machinery; as, if the electric current produced by the engine were used to control its speed, it became possible either to run the engine at a practically uniform speed in connection with a perfectly compounded dynamo, or to run it at a varying speed, maintaining either a constant difference of potential with a varying current or a constant current. Further, it was shown that by utilising the changes in the current to control the engine, it was possible when the load was suddenly decreased to effect what was impossible with a speed governor, namely, to shut off for a time the whole of the steam supply before the engine had had an opportunity of increasing its speed. A number of appliances which had been devised during the last 15 years and tested for electrical regulation were described, some as examples of what should be avoided, and others as successful. In most of these latter a solenoid, the core of which was held in a varying position within it by the current, was connected in different ways to the valves. Two forms of electric motors for altering the position of valves were also shown, and other forms of relays. The advantage of the direct connection of the solenoid was very great over any form of relay. The paper concluded with a description of a method of electric control of a valve gear which was suitable for engines of large size, the power required to govern the lever being practically *nil*, a small solenoid and a slight current being found sufficient to effect the entire control of engines up to 1,000 horse-power. An automatic method of stopping or slowing the engine, should there be an accidental breaking of the governor circuit, was also illustrated by drawings and working models.

The Impurities of Commercial Aluminium.—A recent paper by Mons. H. Moissan on this subject should be studied by all who are interested in the future of aluminium. He contends that when the metal is produced by electrolytic processes, whatever their special nature, it is always impure, and variable in composition. Up to the present it has been assumed that the impurities are only two, namely, iron and silicon. He confirms the presence of these, and names some others which he has detected. Iron, he says, has an unfavourable influence upon the physical properties of the metal; but contamination with it may be avoided by exercising due care in the selection of the raw materials, the crucible, and the electrodes. Silicon being chiefly derived from the alumina that is employed in the process of manufacture, is more difficult to eliminate; but for many of the applications of aluminium this impurity is of no moment. Mons. Moissan considers that its amount may be readily reduced by fusing the metal beneath a layer of an alkaline fluoride. In addition to iron and steel, the author finds that commercial aluminium contains nitrogen and carbon. The former probably exists as a nitride, and its effect upon the metal is to reduce considerably the breaking strain and elongation. As regards the effect of carbon on the physical properties of aluminium, the following figures are expressive:—

	Limit of elasticity.	Breaking strain.	Elongation.
	Kilos. per square mm.	Kilos. per square mm.	Per cent.
Aluminium, of good quality	...	11·1	9
Aluminium, carburetted and cast	...	8·6 to 6·5	3 to 5
Aluminium, carburetted and rolled	20	20·8	2·5
Aluminium, carburetted and rolled, and annealed ...	7·7	13·8	26·5

The paper from which this is condensed may be found in the *Comptes Rendus*, cxix., p. 12.

A New Submarine Cable.—A proposition has been lodged with the French Chamber of Deputies for a submarine cable between Tamatave, in Madagascar, and the Islands of Reunion and Mauritius, and has been passed on to the Budget Commission.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electro-Alkali Company, Limited (37,211).—The annual return of this company, made up to January 3rd, was filed on January 21st. The capital is £160,000, in £10 shares, of which 10,000 are ordinary, 5,000 preference, and 1,000 deferred. The last-named have been taken up, and a call of £2 per share made. £1,990 has been paid, leaving £10 in arrears.

Elmore's American and Canadian Patent Copper Depositing Company, Limited (35,671).—The annual return of this company, made up to January 14th, was filed on January 23rd. The capital is £200,000, in 65,000 priority and 35,000 deferred shares of £2 each. The deferred have all been issued as fully paid. 44,788 priority have been taken up, and the full amount called. £86,044 15s. has been paid, leaving £3,534 5s. in arrears.

Electrical Purification Association, Limited (27,005).—The annual return of this company, made up to December 28th, was filed on the same day. The capital is £25,000 in £1 shares, and 18,326 have been taken up; 5,000 of these have been considered as fully paid, and the full amount has been called on the remainder, and, with the exception of £100, paid.

Smith and Chamberlain, Limited (22,446).—This company has recently filed its annual return, showing that 1,528 shares have been taken up out of a nominal capital of £100,000 in £10 shares. Of these, 1,521 have been issued, with £8 per share considered as paid, while a similar amount has been paid on the remaining seven shares.

Elmore's German and Austro-Hungarian Metal Company, Limited (32,457).—This company filed its annual return on January 10th, when 74,218 ordinary and 13,580 preference shares were subscribed for out of a capital of £250,000, in 75,000 ordinary and 50,000 preference shares. The full amount has been called, and, in consequence, £171,191 1s. has been paid, leaving £3,404 19s. in arrears. In addition, 782 shares have been forfeited, together with the £612 10s. paid on them.

Europe and Azores Telegraph Company, Limited (39,452).—The annual return of this company which has just been filed, shows that 16,700 shares have been taken up out of a capital of £200,000 in £10 shares. Of these 5,568 have been issued as fully paid, and the full amount has been called and paid on the remaining 11,132 shares.

Weybridge Electric Supply Company, Limited (33,680).—The annual return of this company was filed on February 11th last, when 1,487 shares were taken up out of a capital of £15,000 in shares of £5 each. 1,480 of these have been issued as fully paid, and the full amount has been sent in with respect to the rest.

CITY NOTES.

The Brighton Corporation Accounts.

It gives us much pleasure to note the rapid rate of progress which the Brighton Corporation accounts reveal. The output and the incomes have been doubled with no very great increase in the capital expended. It is evident that the "Wright" system of reduction in the price of current is a real one judging from the average price obtained per unit. The station is worked on most economical lines, and Mr. Wright is to be congratulated on bringing it to its exceedingly efficient state.

It is perhaps necessary to explain that for repairs and maintenance we have omitted £605 for repairs and maintenance on consumers' premises, which we consider is more than balanced by the amount received for rent of apparatus. In the same way we have left out £419 for attention and repairs to arc lamps, as a separate charge is made for these.

	1892.	1893.	1894.
Total capital expended ...	£53,000	£78,541	£119,382
Number of units sold	156,000	286,900	583,701
Number of lamps connected ...	11,250	17,000	38,000
Revenue from sale of current...	£4,540	£7,393	£15,298
Net revenue	—	—	£9,800
Average price obtained per unit	—	—	4·5d.

Cost of Production.	£	s.	d.	Per unit.
Coal	2,016	4	5	·83d.
Oil, waste, water, and engine room stores	558	17	0	·23d.
Salaries and wages at generating station	993	15	0*	·40d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	631	4	0	(Works cost 1·71d.) ·25d.
Rates and taxes	23	4	10	·01d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,178	11	9	·48d.
Sinking fund	1,557	0	0	·64d.
Extinction of stock	2,351	7	10	·96d.
Total	£9,310	4	10	3·80d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	15,298	5	1	4·5d.
Meter rents	614	4	10	—
Sale of lamps	—			—
Total	£15,912	9	11	4·5d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·20d.; works cost, 1·71d.

* We arrive at this figure by adding to wages at generating station, half the sum put down for wages and repairs under distribution. This may be therefore underestimated.

The Hull Corporation Accounts.

We have received the 1894 Board of Trade Accounts of this highly successful undertaking. We do not think that any work is more maligned, more misrepresented, and more bitterly attacked than Corporation electric light operations; it is therefore very opportune to be able to confront the arguments of the opponents of municipal enterprise by such sound convincing figures as those which show the year's working of the Hull Corporation Station. There is no doubt about it that a municipality can make electric light works pay where a company would be almost a failure. Still we have no wish to enter upon a discussion of the respective merits of joint stock companies and municipalities; suffice to say that the Hull Corporation, after paying interest and sinking fund charges, are left with the handsome profit of £1,891. This is considered so satisfactory that it is proposed to make a reduction in the price per unit from 6½d. to 5½d. The lowering of price will not take place, however, till next July, so the next year's accounts will scarcely show the result of the experiment.

We can really congratulate Mr. Gibbings on the excellent year's working, and the low costs which we give below will bear comparison with any undertaking in the kingdom.

	1892.	1893.	1894.
Total capital expended	—	£32,818	£39,031
Number of units sold	—	74,600	163,357
Number of lamps connected ...	—	8,035	14,20
Revenue from sale of current ...	—	£2,211	£4,601
Net revenue	—	—	£2,944
Average price obtained per unit..	—	7d.	6·7d.

Cost of production.	£	s.	d.	Per unit
Coal	496	18	4	·73d.
Oil, waste, water and engine room stores	60	10	2	·09d.
Salaries and wages at generating station	506	1	3	·74d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	189	12	9	(orks cost 1·84d.) ·28d.
Rates and taxes	143	0	0	·21d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	553	12	3	·81d.
Sinking fund account	959	19	6	1·41d.
Total	£2,909	14	3	4·27d.

Revenue.	£	s.	d.	Average pric obtained per unit.
By sale of current	£4,601	1	9	6·7d.
Meter rents	115	14	2	—
Other items	182	4	5	—
Total	£4,899	0	4	6·7d.

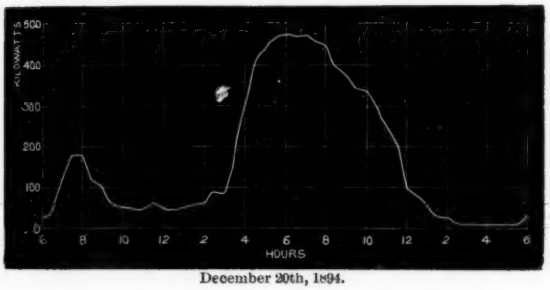
Total cost per unit (exclusive of depreciation and renewal accounts), 2·83d.; works cost, 1·84d.

More Reductions in Price.

The Bournemouth and District Electric Supply Company, Limited, has announced to its customers that from and after March 31st inst. the price of current will be reduced from 8d. to 7d. per B.T.U. The sliding scale of discounts heretofore conceded and calculated upon the gross annual consumption will be abolished and the "Wright" system applied to those consumers who may desire it, 5d. per B.T.U. being charged for all current consumed in excess of 300 hours' use per half year of the maximum current taken as shown by a maximum demand indicator.

Chelsea Electricity Supply Company, Limited.

We have already briefly referred to the accounts of this company. With the assistance of the secretary, we are enabled to supplement our remarks by the subjoined table, which shows the cost per unit. In every respect there is an improvement on those obtained last year, and we congratulate the engineer most heartily on the satisfactory condition to which he has brought the system. From the cost of repairs and maintenance we have deducted the sum of £30 for the maintenance of meters on consumers' premises. We do not think that this sum, considering the meter rents received, can be



December 20th, 1894.

properly included in the general repairs and maintenance account. Nor do we think that the amount paid for meter winding, reading, &c., ought to be lumped in the general wages account; indeed, if the accounts had shown it, we should have felt inclined to deduct that sum. The amounts received for rental of meters are usually considerable, and would be legitimately employed to wipe out cost of up-keep and attention. We are able to publish an interesting load curve of the station, which shows that on an average winter's day, a fairly steady load is maintained for some considerable time.

	1892.	1893.	1894.
Total capital expended ...	£81,364	£99,482	£119,705
Number of units sold	357,162	402,848	469,515
Number of lamps connected ...	34,876	40,665	47,286
Revenue from sale of current...	£11,905	£13,078	£14,788
Net revenue	—	—	£8,096
Average price obtained per unit	—	7·7d.	7·56d.

Cost of Production.	£	s.	d.		Per unit.
Coal	2,080	13	3		1·06d.
Oil, waste, water, and engine room stores	381	3	3		·19d.
Salaries and wages at generating station	1,322	15	10		·67d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	712	15	7	(Works cost 2·28d.)	·36d.
Rates and taxes	725	7	5		·37d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,974	7	8		1·00d.
Depreciation of buildings and plant account .. .. Renewal fund account	1,500	0	0		·79d.
Total	£8,697	3	0		4·44d.

Revenue.				Average price obtained per unit.
By sale of current	£14,788	3	7	7.56d.
Meter rents	533	16	11	—
Total	£15,322	0	6	7·56d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·65d.; works cost, 2·28d.

Liverpool Electric Supply Co., Limited.

The cost of working of the Liverpool Electric Supply Stations are invested with more than ordinary interest at the moment, for in all human probability the balance-sheet before us will be the last but one issued by the Liverpool Electric Supply Company. It may be said that we are anticipating matters a little, we admit it. But those who have watched the progress of events in Liverpool can see no other possible conclusion than that the splendidly organised works of the Liverpool Company will be taken over by the Corporation. We can see no other outlet from the position. The Corporation are filled with a laudable desire to become suppliers of electricity; they must either start works themselves or buy over the existing system of the local company. Under the circumstances it would be a fatal mistake for the municipality to commence opposition works. It would have against it, the large *clientèle*, the great experience, the special knowledge, and the interests of the shareholders, besides which we should imagine that the ratepayers would view coldly any such attempts at rivalry. This, of course, is assuming that the Liverpool Company are actuated with a desire to dispose of their business at a fair price. There is usually an unfortunate tendency to over-estimate the value of a concern when it is needed by a municipality. We trust that no such reprehensible course will be adopted at Liverpool, for although it would be an unwise step on the part of the Corporation to become rivals of supply, it would ultimately work disaster to the Company.

As we have already said the accounts of the Company are of special interest for the above reasons. With those facts before us it is particularly gratifying to see that the Company has surpassed its previous efforts in every respect. It would be difficult, of course, to compare the working costs which obtained in 1894 with those of the previous year, for in 1893 the disastrous effects of the coal strike were being felt in all directions, and it, no doubt, affected this Company to some extent. The costs are as follows:—

	1892.	1893.	1894.
Total capital expended ...	£186,439	£214,222	£252,152
Number of units sold	796,281	873,325	1,016,178
Number of lamps connected ...	20,000	25,000	31,792
Revenue from sale of current...	£23,200	£24,735	£28,906
Net revenue	—	£9,589	£15,898
Average price obtained per unit	—	6·9d.	6·8d.

Cost of production.	£	s.	d.		Per unit.
Coal	2,869	15	6		·68d.
Oil, waste, water, and engine room stores	387	0	7		·09d.
Salaries and wages at generating station	1,091	3	7		·26d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	2,493	2	5	(Works cost 1·62d.)	·59d.
Rates and taxes	440	8	3		·10d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	3,011	0	7		·71d.
Depreciation of buildings and plant account	3,838	8	1		·90d.
Renewal fund account	2,500	0	0		·59d.
Total	£16,630	19	0		3·92d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	28,906	11	4	6·8d.
Meter rents	1,138	9	5	—
Sale of lamps	572	0	9	—
Total	£30,617	1	6	6·8d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·43d.; works' cost, 1·62d.

The Hove Electric Lighting Company.

We have received the report and accounts of this company, but we shall defer a consideration of them till next week.

Cambridge Electric Supply Company.

Through the courtesy of Mr. Barker we are enabled to give the costs per unit of the various items of the expenses account. It is, of course, very necessary to remember when considering these figures that the conditions of lighting which exist at Cambridge are very exceptional. The average consumption per lamp and the price obtained

therefrom are exceedingly low, the revenue per 8 C.P. lamp being very little more than 5s, while the consumption during the darkest four weeks in the year was a good deal less than that obtained in the month of October. It is very curious to find that cost of production for the last six months of 1893, and the last half of last year are exactly identical. The costs are as follows:—

	1892.	1893.	1894.
Total capital invested	—	£29,517	£31,503
Number of units sold	—	43,893	112,025
Number of lamps connected ...	—	1,093	11,644
Revenue from sale of current...	—	£1,267	£3,151
Net revenue	—	—	£93
Average price obtained per unit	—	6·9d.	6·7d.

Cost of Production.	£ s. d.	Per unit.
Coal	1,105 16 4	2·36d.
Oil, waste, water, and engine room stores	127 17 1	·27d.
Salaries and wages at generating station	511 8 3	1·09d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	270 14 9	(Works cost) 4·29d. ·57d.
Rates and taxes	203 1 7	·42d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	241 10 2	·51d.
Depreciation of buildings and plant account, and written off formation expenses	268 10 11	·57d.
Renewal fund account	—	—
Total	£2,728 19 1	5·79d.

Revenue.	£ s. d.	Average price obtained per unit.
By sale of current	3,151 10 8	—
Meter rents	242 18 7	6·7d.
Sale of Lamps	—	—
Total	£3,394 9 3	6·7d.

Total cost per unit (exclusive of depreciation and renewal accounts), 5·22d.; works cost, 4·29d.

Chelsea Electricity Supply Company, Limited.

Mr. J. Irving Courtenay presided at the meeting of this company held at Draycott Place, on Tuesday last. He said he thought that any difference which existed between the accounts for 1893 and those for 1894 was a matter on which the shareholders were to be congratulated. This result has been attained partly by a reduction on all the items of expenditure relating to the manufacture of the electricity; it was also partly due to increased volume of business. Although they had to pay a larger price per ton for coal (an average of 9 per cent. higher than in 1893) the coal used to produce each unit comes out at a lower cost; wages, stores, and maintenance were also less. The capital expenditure in 1894 amounted to a little over £20,000. The building operations (£2,425) have taken place chiefly in such improvements in Cheyne Walk Station as will enable them to take advantage of the best arrangement of the machinery, and in the construction of a new and commodious sub-station in Pavilion Road capable of meeting the rapidly-growing demand of the northern part of their area. The generating plant purchased and fixed (£9,186) had been mainly for the further equipment of the Cheyne Walk Station. That plant was now in full work; and the advantages of having the latest improvements both in the design and in the arrangement of the plant will be beneficially felt during the current year. The item of accumulators and transformers (£3,018) was for the equipment of accumulators at Cheyne Walk, and of accumulators and continuous current transformers at Pavilion Road sub-station. The amount of £4,979 for mains was for extensions arising out of the increased demand. The capital expenditure per lamp (£2 9s. 4d.) fixed was as low as that of any other company in the metropolis, and what he had just mentioned points rather to them retaining that advantage. The premises at Cheyne Walk would be able to contain plant sufficient, when fully equipped, to supply the needs of fifty or sixty thousand lamps. Draycott Place Station was fully occupied, and continues to work satisfactorily. During the year, Callender-Webber cases have been laid for a distance of over 4,250 yards, and have a capacity for accommodating nearly 20,000 yards of conductor, the cable actually drawn in being over 17,000 yards in length. In the early days, before the operations of the company were of sufficient magnitude to command financial success, and at a time when the public looked with some distrust at what was then an entirely new field of enterprise, they had to obtain capital on somewhat onerous terms. The debentures then issued carried interest at 6 per cent., and it was not an easy matter to place them even at that rate. £30,000 was, however, obtained on first mortgage debentures, and these fall due in September this year. A short time afterwards a further small issue of £6,900 second debentures was made; this latter class being redeemable at six months' notice. He was glad to say that the present condition of the electric lighting industry, and their own vastly improved position, enabled them now to obtain capital on more reasonable terms. He then moved that the report of the directors and statement of accounts for the year 1894, before the meeting, be and they are hereby adopted, and the payment of a dividend of 6 per cent. on the preference share capital, and of 5 per cent. on the ordinary share capital, for the year 1894, be and is hereby approved, payable forthwith.

General Webber seconded the resolution. The retiring directors and the auditors were re-elected.

The Chairman then proposed the following resolution:—"That the power to borrow or raise money, conferred on the directors by Clause 43 of the Company's Articles of Association, be extended so that they may be at liberty to borrow or raise money to such an extent as they may from time to time think expedient; provided that the amount at any one time owing in respect of money so borrowed or raised shall not, without the sanction of a general meeting of the company, exceed the amount of the subscribed capital for the time being and from time to time of the company."

This was seconded by General Webber, and carried.

The Edison and Swan United Electric Light Company, Limited.—The directors have resolved: That a payment on account of the dividend of the current year be made at the rate of 5 per cent. per annum, less income-tax, on the "A" shares of the company, for the half-year ended 31st December, 1894. This will work out as follows:—On the 89,261 ordinary shares, £3 paid, 1s. 6d. per share; on the 5,000 shares, £5 paid, allotted to the Edison Electric Light Company, Limited, 2s. 6d. per share; on the 12,139 shares, £5 paid, allotted to the Swan United Electric Light Company, Limited, 2s. 6d. per share—less income-tax. The payment will be made upon the register as it stands this day (March 5th), and the dividend warrants will be issued on the 20th instant.

Northampton Electric Light and Power Company.—The annual meeting of the shareholders of this company was held yesterday week. The Mayor (Councillor W. Tomes) was in the chair. The accounts were laid before the meeting. It was pointed out that the actual revenue earned was £762 7s. 8d., compared with £536 1s. 1d. in the previous year, and that provision was now made for depreciation. Mr. R. Cleaver and Mr. R. Price, the retiring directors, were unanimously re-elected, and a resolution was passed for payment of a dividend on the preference shares.

British Electro-Chemical Agency, Limited, and Reduced.—A petition has been presented to the High Court of Justice (Chancery Division) for confirming a resolution of this company for reducing its capital from £75,000 to £50,000. A list of the persons admitted to have been creditors of the company on February 1st, 1895, may be inspected at the offices at Queen Street Chambers, Queen Street, E.C., or at the office of the solicitors, Messrs. Spreat and Bullivant, 27, Nicholas Lane, E.C.

The Brush Electrical Engineering Company, Limited.—The directors have declared an interim dividend for the six months ended 31st December, 1894, at the rate of 6 per cent. per annum on the preference shares, and at the rate of 5 per cent. per annum upon the ordinary shares, payable 18th March, 1895. The transfer books of the company will be closed from 5th March to 19th March, both inclusive.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended December 31st last, and payable on the 22nd inst. The transfer books of this company will be closed from the 15th to 21st inst., both days inclusive.

Cambridge Electric Supply Company, Limited.—The third annual meeting of this company was held last week, when the report and accounts were adopted.

The Commercial Cable Company.—A quarterly dividend of 1¾ per cent., payable on April 1st, has been declared.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending March 3rd, 1895, amounted to £953; week ending March 4th, 1894, £934; increase, £19; total receipts for half-year, 1895, £8,940; corresponding period, 1894, £8,544; increase, £396.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of February were £4,000; as compared with £3,639 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of February, 1895, amounted to £1,690, against £1,698 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in February, 1895, were £21,200; January 1st to February 28th, 1895, £44,400; corresponding months, 1894, £48,000; corresponding months, 1893, £41,200.

The Liverpool Overhead Railway Company. The traffic receipts for the week ending March 3rd, 1895, amounted to £934; corresponding week last year, £635.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 1st, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,073.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, February 27th.	Closing Quotation March 6th.	Business done during week ended March 6th, 1895. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	101 —104	101 —104	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	40 — 41	40 — 41	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	75½ — 76½	75½ — 76½	76¼	75⅞
2,993,560£	Do. do. Defd.	Stock	...	...	...	6½ — 6⅝	6 — 6½	6½	6
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	11⅜ — 12¼	11⅜ — 12¼	12¼	11 1/16
75,000£	Do. do. 5 %, repayable June 1906	100	5 %	5 %	...	109 —113	109 —113	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	10%‖ §	... §	...	3 — 4	3 — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	148 —152	148 —152	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	...	1/16 — 3/16	1/16 — 2/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4 %	4 %	4 %	4 — 4½	4 — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9½ — 10	9½ — 10	...	...
30,000£	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	2⅝% §	2 %	8½ — 9	8½ — 9	9	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	16½ — 16½	16½ — 16½	16½	16¼
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	17½ — 18	17½ — 18	17⅝	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	...	...
1,297,837£	Do. 4 % Mort. Deb.	Stock	4 %	4 %	...	124 —127	124 —127	125½	123½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17⅛ — 17⅜	17⅛ — 17⅜	17⅜	17⅛
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	103 —107	103 —107	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	104 —107	104 —107	106½	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	123 —126	123 —126	...	...
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	103 —107	103 —107	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	5 %	5 %	...	104 —107	104 —107	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	4 %	4 %	...	106 —109	106 —109	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115	112 —115%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	...	9⅝ — 9⅞	9⅞ — 10	10	9⅞
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	...	16⅝ — 16¾	16⅝ — 16⅞	16⅞	16⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	...	22 — 22½	21¾ — 22¼	21 15/16	...
190,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	106 —109	104 —107	105	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	53 — 55	53 — 55	54	53¼
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½%	...	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	6 %	6 %	..	105 —109	105 —109 xd	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	... — ...	... — ...	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	6 %	6 %	...	1¼ — 2½	1½ — 2½	...	..
484,597	National Teleph., Ltd., 1 to 438,984	5	5 % §	5 % §	5 %	5½ — 5⅝	5½ — 5⅝xd	5½	5¼
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15½ — 16½	15 — 16 xd	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	15 — 16	14½ — 15½xd	15	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	5 %	5 %	...	6 — 6¼	5⅞ — 6 xd	5 15/16	5 11/16
1,100,000£	Do. 3½ % Deb. Stock Red.	...	3½%	3½%	...	104 — 106	104 —106	105⅛	104⅛
48,800	New Teleph., Ltd., 25,901 to 74,700 ; £4 paid	10	...	...	...	... — ...	... — ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	9/16 — 11/16	9/16 — 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	...	3½ — 4½	4 — 5	4 7/16	...
3,381	Submarine Cables Trust	Cert.	...	...	...	118 —123	119 —124	123	122
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	86 — 91	85 — 90 xd	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	0 %	...	4 — 5	4 — 5	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 —106	101 —104 xd	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½ — 2½	1½ — 2½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —103	98 —103	...	...
64,245	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3¼%	10 — 10⅛	10⅛ — 10⅜	10⅜	10 7/16
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	5 %	5 %	5 %	6¼ — 6½	6½ — 6⅝	6 7/16	6⅜
33,129	Do. do. do. 5 % Def.	7½	...	...	...	4 — 4½	4⅛ — 4⅜	...	...
171,900£	Do. do. do. 6 % Debs. "A," 1910 ...	100	6 %	6 %	6 %	101 —105	101 —105	...	...
214,800£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	6 %	6 %	6 %	101 —105	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅜%	⅜%	1 — 1¼	⅞ — 1⅛	1	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	6 %	6 %	6 %	10⅜ — 11¼	10⅜ — 11¼	11⅛	11
4,669	Do. do. do. 6 % 2nd Pref. ...	10	6 %	6 %	6 %	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	5 %	5 %	5 %	108 —111	108 —111	...	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	115 —120	115 —120	...	...
166,900£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	104 —105	101 —103 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5 — 5⅛	5 — 5⅛xd	5⅛	.
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	13½ — 14½	13 — 14 xd	13⅝	13⅜
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15¼ — 15⅝	15 — 15½xd	15⅝	15 7/16
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —136	133 —136	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5¼%	7¼ — 7⅜	7 1/16 — 7 7/16	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	...	9¼ — 10¼	10⅛ — 11¼	11	10⅛
100,000£	Do. 5% Deb., bonds of £10, £20, £40	...	5 %	5 %	...	... — ...	... — ...	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	118 —120	118 —120	119½	118
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	7 — 7⅛	7¼ — 7⅜xd	7⅛	7⅛
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	7½%	4½%	6½%	7½ — 8	7½ — 8	7⅝	7⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½ — 9	8½ — 9	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7½ — 8	7½ — 8 xd	7⅝	7 9/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Feb. 27th.	Closing Quotation, March 6th.	Business done during week ended March 6th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §	6 % §	...	2⅝ — 2⅞	2¼ — 2⅜	2 3/16	2 9/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2⅜ — 2⅝	2⅜ — 2⅝	2⅝	...
125,000*l*	Do. do. 4½ % Deb.	Stock	4½%	4½%	....	115 —118	113 —116 xd	115½	...
630,000*l*	City and South London Railway	Stock	⅝%	⅝%	1¼%	46 — 48	45 — 47	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	3 — 3½	3 — 3½	...	...
50,000*l*	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	5 %	5 %	...	102 —107	102 —107	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	*nil*	*nil*	...	¼ — ⅛	¼ — ⅛	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1½ — 1⅝	1½ — 1⅝	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	...	... — ...	... — ...	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	1½ — 1⅝	1⅝ — 1⅝	1½	1 7/16
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1⅜ — 1⅝	1⅜ — 1⅝	1 7/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	½ — 1½	½ — 1½	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	...	10 — 11	10 — 11	10⅜	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	23½ — 24½	23 — 24 xd	23⅝	...
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	8 9/16 — 8 11/16	8½ — 8⅝	8 17/32	8½
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	13 — 13½	13½ — 13⅝	...	...
	Swan United Electric Light, Ltd.	...	10 % §	7½% §	...	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	45 — 47	39 — 41 xd	44⅛	39½
150,000*l*	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2¼ — 2½	2¼ — 2½	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50°/ for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0°/₀§; 1891—7°/₀§; 1890—8°/₀§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.
Electric Construction Corporation, 6 % Debentures, 84—87.
Electric and General Investment, shares of £5 (£1 paid), 1¼—2
House-to-House Company (£5 paid), 3¾—4.
Do. do. 7 % Preference, of £5, 7⅛—⅜.
Do. do. 6 % Debentures of £100, 107—108.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 7¼—7¾; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 7¼—7½
London Electric Supply Corporation, £5 Ordinary, 7s.—9s.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 98—100.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5¼—5⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Discussion on Reversible Regenerative Armatures and Short Air Space Dynamos. By W. B. Sayers, Associate.

The President said he was sure they had all listened with great pleasure to Mr. Sayers's explanation of his paper, and he put it to them that they voted him thanks for putting so interesting a paper before them. The question was one of exceeding importance to them all at the present moment. They all knew the object of short air space design was to minimise the quantity of material necessary in the construction of dynamos and motors, and they knew that in ordinary designs with short air space they had great trouble with the commutators and the commutating arrangements generally. Mr. Sayers claimed, and he (the President) believed justly so, to have overcome those difficulties, but up to the present time it had not been an easy matter to make the machines reversible, and they had now to thank him for the further development he had put before them that evening.

Mr. F. V. Andersen* said he had not had much experience in his practice with short air spaces or with tunnel winding, and he had not had the good fortune to see any of the machines of Mr. Sayers. He was looking forward with great anxiety to see a run with one of these machines, because there were a great many problems which appeared to him very difficult to solve when tunnel winding was adopted, such questions as to what the amount of hysteresis was round the conductors when the current changed in the tunnels, and as to the eddy currents in the pole-pieces in the field. He would not criticise the plan Mr. Sayers put forward, and he only mentioned these matters as things which were important, and he would like to know if any measurements had been made as to the amount of this hysteresis and the eddy currents in the field. There could be no doubt about the fact that there were troubles which they did not find if they used smooth core armatures. If these difficulties could be overcome, this plan of making an armature, which Mr. Sayers called regenerative, must be quite generally adopted, except in one particular case, where shunt machines were required. He could not, of course, make shunt machines on this plan, Mr. Sayers' machine was virtually a compound machine, even when its field was shunt wound, and many of the machines now wanted in special cases must be shunt machines, say for central station where all the machines were run in parallel. He saw in the paper Mr. Sayers had a plan for taking away the danger for machines for parallel running.

Mr. Sayers said he would point out that the machine shown in fig. 5 was a shunt machine. The suggested new arrangement for the parallel running was only for use when the machine was so designed as to give a rising characteristic.

Mr. Andersen*: Yes; but I mean the danger of reversal will come in on account of the regenerative action of the armature to a certain extent.

Mr. Sayers*: Well, I do not find that. I have had some experience with that, and I do not find that even with a rising characteristic of the armature, any actual reversal takes place on account of the very small number of turns in the armature as compared with the field.

Mr. Andersen,* resuming, said, in his opinion, it was only a question of so proportioning the actual shunt, which was put in in the ordinary way, to the back turns in the armature to avoid the danger. That, of course, would effect the saving in material that they had in the ordinary way in this armature. He wished to thank Mr. Sayers for the valuable details he had given, such as the very business-like statement giving all the particulars of weights of an 80-unit machine at a given speed. It might be of some interest if he gave a few figures which he had picked out from his own designs, and in which he could show a reason for his statement that there was a most important saving to be gained in the weight of the machine. Taking the four first items, magnets, magnet coils, armature and windings, Mr. Sayers's figures came to about 64½ cwt. for what might be called the active material of the machine. Taking the ordinary well known single horseshoe machine, if they made it a first-rate machine, with 96 per cent. electrical efficiency, and made an equivalent machine on that plan, which was a very general one, the weight of those four items, when they went really economically about it, he found to be 85½ cwt. Mr. Sayers's was 75½ per cent of that, so that there was a gain of 24½ per cent. This gain, of course, did not go right through. There was a greater proportion of gain in the cast steel. But the armature was larger and heavier, so that there was some 34 per cent. more weight in the core and shaft, and 21½ per cent. more armature copper in Mr. Sayers's machine than in the single horse-shoe machine. In the labour, too, he suspected that Mr. Sayers's machine was considerably more expensive, as a good deal of labour was involved in the larger armature and the larger amount of armature copper. Still, so far as compound machines were concerned, there must be at least a saving of 10 per cent. in the cost. The advantage of fixed brushes he considered to be great where they could have them. They were unnecessary in central stations, but they were an important improvement.

Mr. W. M. Mordey* said he had not intended to speak, but

* Speakers names with an asterisk attached have corrected their remarks.

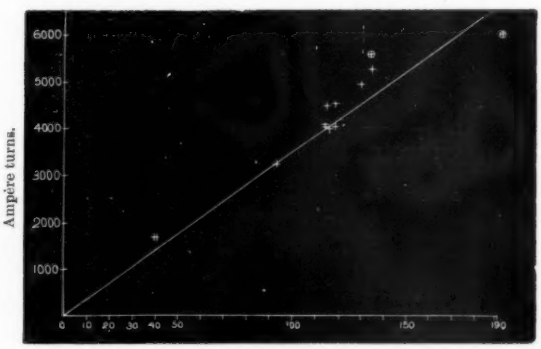
as he had been called upon he would like to make an objection to a new term that Mr. Sayers had tried to introduce. He thought they ought to be very jealous in regard to the introduction of new terms. Although the term mentioned in the second paragraph had received the apostolic benediction of Lord Kelvin, he ventured to think they ought not to receive the name "keeper" for field magnets. What was the origin of the term keeper? In the pre-historic days, the cave men found that ordinary magnets kept their magnetism longer if they put a nail across them, and they called that a keeper. But there was no kind of analogy between that and the function played by the field magnet.

Mr. Sayers* said he only meant that to refer to machines without any windings on the magnets, and of which the armature itself was the exciting power.

Mr. Mordey* said with or without winding on the magnets, he thought the term was not a good one. It did not make it a keeper any the more for having no winding on it. Then he would like to object to the use of the new term, "regenerative armature." He did not like that term at all. If it was different from other armatures, let them call it the Sayers armature. He did not think they could distinguish it in any better way, and he was sure Mr. Sayers deserved that he should be distinguished by having his armatures called after him. Still another term he objected to, and that was the use of the word "blades" for commutator sections. They had been in the habit of calling them sectors; they were not exactly sectors, for sectors, he believed, went right to the centre—truncated sectors they ought to be called, but that was too long. Blades were suggestive of Boadicea's car, with sword blades on the hub and the periphery of the wheels, and was altogether an objectionable term. He hoped Mr. Sayers would stick to sectors, which satisfied them all. The object of the paper, as he understood it, was to introduce to them an improvement by which Mr. Sayers had made his very clever arrangement suitable for machines that were capable of running in either direction. They were glad to know that he had got over that difficulty. He had got over it by using twice the number of commutator coils, or by using twice the space for commutator coils. With reference to the reduction of the number of sectors, Mr. Sayers pointed out that with his arrangement it was not necessary to have a large number of sectors in the commutators. Of course, in ordinary machines, we tried to approximate to the condition of a brush running along a continuous wire. A machine with an infinite number of sectors would be one in which the brush ran right along the conductor. This smooth condition was only allowed in the unipolar machine. The author pointed out that it was possible, on account of the ease with which the sparking was overcome, to increase the number of sectors, and stated that they might go down very far in that direction. A point which perhaps he had omitted—or if he had not omitted it he might explain—that if you got a circuit in which the current was pulsating, you got an alternating current, which they knew was a very bad thing indeed. Mr. Sayers's correcting arrangement—he liked the word "correcting," which was better than the word commutating, as applied to this arrangement—was not applied to the outside circuit, so that if the outside circuit had any self-induction, you got sparking due to the outside circuit. He must congratulate Mr. Sayers on the plain English of his paper. They were not used to having dynamo papers in which authors told in plain English what they meant. It was a great relief to have one.

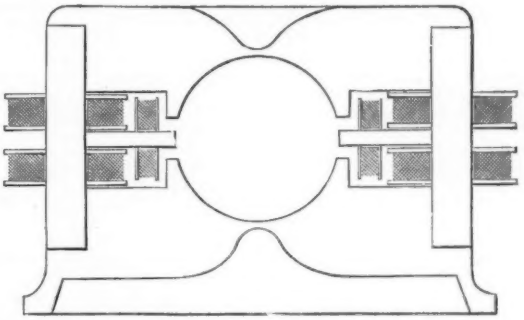
Mr. H. A. Mavor* said the paper necessarily interested him as the manufacturer of the machine which it described. He wished to give the fullest credit to Mr. Sayers for the energy he had shown in overcoming the difficulties incident to the projection of so entirely new a method of design, and his firm had great pleasure in standing by and paying the piper for the experiments—all the more pleasure that, he was glad to say, not one of the machines had turned out to be an experimental machine. They had made nearly 100 of them, and every one had worked satisfactorily, including the first one made. That, he thought, indicated the possession by Mr. Sayers of what he might call the "rectifying eye," or the "commutating eye," because of course, in the first instance, the construction of these machines was not a question of calculation. Experiments had to be made, and as Mr. Sayers had told them the formula on which he based his practice now was an empirical one, and the fact that that empirical formula had been made up by experience in a large number of machines, all of which had been satisfactory, was rather remarkable. At first sight it looked difficult to calculate the results of the application of this system, but it had great flexibility in it, and so far had proved perfectly successful in all the directions the author had indicated. In the paper there was reference to a variety of designs of slots which had been used in these machines. So far as he could see, only two sections had been shown. A great many others had been tried, and all gave satisfactory results. With regard to the question of parallel running he (the speaker) had had the opportunity of making some experiments with the 80-kilowatt machine represented in fig. 5, and so far from experiencing any difficulty whatever in switching it into parallel, the expression used by the engineer-in-charge was that it was "greedy for the load." It took up the load very easily, and without any shock to the engine driving. It would be evident to them, he thought, that if the dynamo had a rising characteristic, the engine immediately pulled up and the difficulty remedied itself. In this machine, however, the armature forward magnetising turns were not very many, and the characteristic was nearly horizontal. That was an experimental result which would probably relieve the minds of some who feared that parallel running would be difficult with those machines. He might mention that the difficulty was called prominently to their notice by the attempt to run two machines in parallel which were driven on the same shaft. That was found impossible. The machines were slightly rising in characteristic, and could not be joined. It was not necessary that they should be; but the difficulty could have been got over in a simpler manner than by the use of an auxiliary brush, by putting on a turn or two of back series [winding] to bring down the characteristic. With regard to the fixed position of brushes, that was not quite arrived at in large machines yet; but he thought now they saw their way to it, and that it was not far off. The amount of motion required of the brushes in these machines was very slight indeed. In the 80-kilowatt machine, the largest constructed so far, the brushes required to be moved at half load, and remained fixed up to full load, and had one position from half load down to no load. With regard to the lower formula on the board, he must say he had not very fully thought out the matter; but so far as he could see, the result would be identical if they took the induction as the numerator, and as the denominator, used the ampère turns on the armature multiplied by two, giving the current flux round the armature, and multiplying that by the length in centimetres of the active conductors on the armature. He agreed with Mr. Mordey about the word "regenerative." Regeneration meant "being born again," and did not apply to the present case. He suggested "direct flux." If Mr. Sayers did not like to register his name to posterity in connection with this armature, he thought his suggestion would meet the case, and give a fair indication of what the armature was.

Mr. H. Ravenshaw* said it was generally agreed that Mr. Sayers's invention was one of the best of the last few years in connection with the dynamo, and he thought great credit was due to him for it. At the same time, he must say he thought he put his extra copper in the wrong place. Any continuous current armature was at the best a very complicated affair, with a very large number of bars, a quantity of solder, as a rule, tape, string, and other things. The alternating dynamo, as a rule, was very much simpler. Since Mr. Sayers read his first paper, he (the speaker) had made a few experiments with what he had always known as a cross-field dynamo; that was to say, one with a non-sparking pole at right angles to the ordinary field. He had a diagram of the



Ampères in armature.

+ = Ampère turns in cross field. —— = ampère turns in armature.
⊕ = Sparking (ampère turns in cross field too high or too low).



machine and a curve showing the result of the experiments. It was a machine with 72 sections and 72 notches, and it gave 100 volts and 150 ampères. He altered the magnets slightly, so as to get a little more room, and fitted a small electro-magnet in the middle of each magnet bar, pointing towards the centre, and having the same clearance as the ordinary pole pieces. The cross-field dynamo was, he believed, originally due to Mr. Swinburne. It has been a well-known design, but he had always understood it was not really practicable. He wound the cross field coils with quite small-sized wire, so that he could separately excite those coils—put a certain amount of load on to the machine, and then varied the current in the cross-field until the machine did not spark. He increased it until the brushes began to spark, and then reduced it until they began to spark again, getting the mean reading which he had plotted on the curve. The black line shown was the actual ampère-turns in the armature, and the little crosses showed the ampère-turns on the cross field. As they might see, they agreed practically with the ampère-turns of the armature. The circles and crosses combined showed two points where the machine sparked, one current was too large and another was too small. As a matter of fact, it was not a complicated arrangement. The cross-coils were quite small, and the machine worked perfectly without sparking. The great difficulty was when the load varied there had to be a constant readjustment of the brushes to prevent sparking.

Mr. Mordey: What was the clearance?

Mr. Ravenshaw: About $\frac{3}{16}$ths of an inch—total $\frac{3}{8}$nds a side.

Mr. Sayers: What was the length of the armature?

Mr. H. F. Parshall* said that in the discussion it seemed to have been assumed that the depth of the air gap was of the greatest importance in practice in determining the amount of sparking, change of load, &c. He was not of that opinion. Assuming he was correct, the air gap in the case of projection armatures would be determined from considerations such as the effect of eccentricity of the armature. With respect to the pole-pieces the mechanical strains due thereto, and the effect of the magnetic or electrical unbalancing of the armature circuits. Referring to the dimensions given by Mr. Sayers, he noted, on account of these considerations, Mr. Sayers had adopted the same air gap as he (Mr. Parshall) had found advisable under similar conditions and entirely without reference to sparking, although subsequent experiments had shown the correctness of his (the speaker's) assumptions as to proper length of air gap. The effect of the current in an armature as to sparking was to distort the flux in the air gap, and to set up during the period of commutation a counter E.M.F. due to self-induction. If, therefore, it could be shown that outside the limits fixed by mechanical considerations, varying the length of the air gap did not greatly affect the distortion of magnetic flux nor affect self-induction of an armature coil when in the position of commutation, it was demonstrated, he thought, that the air gap was not at all so important as supposed. Referring first to distortion, it was shown by Dr. John Hopkinson that the distortion with smooth core armatures was $2 \text{K} m c/1 = d$, where d = distortion or difference in magnetisation between the two extremities of the pole arc, K equals the pole arc, or some large fraction of it, $m c$ the magnetomotive force of the armature, and l the length of the air gap. In the case of projection armatures the formula required modification. The reluctance of the circuit around which the magnetomotive force, $2 \text{K} m c$, is exerted is in the first case dependent on the length of air gap, and the displacement of the magnetic flux in the air gap was in that case proportional to the current in the armature. In the case of projection armatures the formula becomes $2 \text{K} m c = l d + \left(a + \frac{d}{k}\right) f_1 l_1 (a) f_2 l_2$, in which a and $\left(a + \frac{d}{k}\right)$, are the magnetisations in the projection at the extremities of the pole arc, K being a factor dependent on the ratio of the section of the pole to the section of the projections; l_1 the length of the projections, and f_1 and f_2 the magnetising force, in which case obviously l (length of air gap), became of less and less importance as the magnetisation and length of the projections increased; d may then be made as small a fraction of a as desired by simply varying the proportion of area of the projections with respect to the section of the polar surface. In practice he had found it economical to limit the length of the air gap to the smallest possible amount consistent with mechanical considerations, and to so proportion the area of the projections that a small distortion of the flux as compared with the initial flux was accompanied with a relatively great increase of reluctance in the projections, in which case projection armatures may be made so as to be less subject to distortion than smooth core armatures. Then, with respect to the inductance of an armature coil in the plane of commutation, it had been found by direct measurement that the increase of inductance was not very great outside the length of gap defined as mechanically necessary, even when a coil was advanced so that its sides were immediately under the poles. Extremely small air gaps were under all cases in large machinery mechanically objectionable. With respect to the statements as to self-induction and distortion, he might point out that in the arc of commutation the inductance E.M.F. in a coil was $\text{E}s = 2 \pi n \text{L} c 10^{-9}$. For sparkless commutation $2 \pi n \text{L} c 10 =$ E.M.F. generated by the flux, or $2 \pi n \text{M} 10^{-8}$, or $\text{L} c 10^{-1} = \text{M}$ (change in number of lines during period of commutation). Having, then, the values of L c and M, each of which might be easily determined by calculation or by experiment for a given type, the lead of the brushes, the arc of commutation, and proper width of brushes is determined. Having reference to the weights quoted by Mr. Sayers, he might say that they did not show any saving in material over several good types of dynamos with which he was acquainted, the extra cost of the additional armature winding being neglected.

Mr. W. B. Esson* said this question of slotted armatures possessed a good deal of interest for him, because he used to make slotted armatures a long time since—about ten years ago—and so far from the clearance of the air gap being about two-thirds of the width of the slot, which he thought it was in Mr. Sayers's machine, he used to have his clearance only about one-third of the width of the slot, and he never had any trouble from sparking at all. The fact was that when they had the air gap sufficient to stop the heating of the pole-pieces, the machine worked perfectly without any sparking, and of course without the complication shown by Mr. Sayers. He looked at this question of construction, of course, from the manufacturer's point of view entirely, and he should like to know how the cost of the machine compared with the cost of an ordinary machine. Mr. Sayers had not explained—in his hearing, at least—the 80-kilowatt machine. If the magnets were made of steel—and it looked as if they were—it was a very expensive casting. These steel castings cost, he supposed, at least 25s. a cwt., and they could buy tooled forgings at 18s. Another thing about that machine which struck him, was that if they wanted to make a different size of machine, say 6 inches longer, it was not so very easy. They had to carve their patterns about to do it, and that, of course, every manufacturer knew was a very expensive job. Whenever anything went into the pattern shop he knew it seldom came out under a few sovereigns. It also seemed to him that the cost of connecting up the auxiliary coils and providing for them in the armature must add considerably to the total cost of the machine. He would like some definite information on the point. It was really the labour they wanted to save in the construction of machines. They could put in £10 worth of material in place of £7 worth of booked labour at any time, and make a profit, and he should like to have particulars from Mr. Sayers as regards the cost of the machine. He was quite free to admit that this was perhaps, from a scientific point of view, a great step in the construction of dynamo machines, but he must ask for a little information before he accepted all that was claimed for this machine.

Mr. G. L. Addenbrooke said he happened to take some interest in the machine, particularly in the last six or eight months, and had the advantage of seeing, during the trial at Messrs. Belliss's, the identical machine, he believed, which Mr. Sayers had illustrated, the 80-kilowatt machine, and he had also since had the opportunity of seeing some of the machines in the course of construction at Messrs. Belliss's works. The first thing they had to consider was that they had to deal with an accomplished fact; on the last occasion when this machine was brought before the Institution there was, perhaps, more or less speculation, but a large number of these machines had been built, and were working satisfactorily. The question was, What advantages had they over ordinary machines, from a user's point of view? Most of those who had spoken at present had been builders of dynamos, and everybody, of course, did not care to change their practice; and, naturally, it was necessary to criticise details considerably. He represented, perhaps, rather a different point of view; but, looking at the machine as a something that they might want to apply to doing one thing and another, he may say he thought it was a considerable advance on previous practice, and unless something else of the same character—and, perhaps, there might be something, from what Mr. Ravenshaw said—was introduced, he thought it must come in. In the first place, of course it was a very great advantage to have all the conductors positively driven, and there was the other point, that having the conductors beneath the surface of the iron, they were not limited to the diameter of the armature. Then, of course, the size of the machine was enormously reduced, much more, perhaps, than might be imagined, and seeing that that 80-kilowatt machine at Belliss's, in comparison with machines of somewhat similar output, it seemed almost a toy, and there was no doubt where weight was a consideration, and bigness, the machine would be very desirable. As regarded keeping the brushes absolutely in one fixed position, he thought it was only fair to say he did not think that was quite attained. The arc through which the brush required moving was certainly exceedingly small, but they did require some movement, and he thought it followed, to a certain extent, from the nature of the problem. What they wanted to get rid of was, of course, the energy which existed in the coil when it was cut out on the circuit, and this energy was dependent on the amount of current that was flowing in that coil, consequently when there was a great current flowing through *here*, they needed to bring *this* up in a stronger field. Well, instead of putting that outside they put it in the slot *here*, and at the same time brought *this* very much closer, and still got *that* action *there* (illustrating). It was of the same character, but very much smaller; they get not quite the same angle, perhaps, but still, in order to get rid of the greater self-induction, which must be got rid of when a large current had been flowing through *that*, they must bring *this* a little nearer. There was this point always to be considered about getting rid of the self-induction from this coil, that they had to produce a backing E.M.F. which had the same current as the back E.M.F. in the coil; that was to say, its rate of rise must be equivalent to the rate at which *this* would form, so that in getting two perfectly sparkless actions, they depended on the pole-pieces having the exact shape of the lines at that point. In the case of Mr. Sayers's machine, where they had armature with a lot of slots round, of course, the induction, as he thought Mr. Swinburne had pointed out, jumped from one to the other. They were not dealing with a coil passing into the field like *that;* the induction was *here*, and went *there*, so to speak, instantly. He meant the lines that passed through that were very small in comparison with what they would be if stationed outside; there was no doubt, in dealing with this machine, that it was a very complicated subject. The more one looked into it, in order to understand continuous current machines perfectly, they must thoroughly understand alternating machines, and when they got that of two-phase machine, the question was whether two and three-phase machines would not be better for the purpose for which continuous currents were adopted.

Mr. C. C. Hawkins* said that through the courtesy of Messrs. Mavor and Coulson he had had an opportunity of seeing the 80-kilowatt dynamo, described by Mr. Sayers, running, and he could bear witness to the efficacy of the auxiliary pole-pieces which were shown in figs. 3 and 4. He thought it was very doubtful whether, without those reversing pole-pieces, the 800 ampères could be successfully commutated, in consequence of the short air space of the dynamo. But the chief objection to them was that, to an appreciable extent, they increased the magnetic leakage; from fig. 5 it was easily seen that there was a comparatively dense flow of lines through the reversing pole pieces, which immediately turned into the portion of the iron covered by the exciting coil. There was one point it was well to note in regard to the dynamo mentioned by Mr. Sayers. In the ordinary continuous current dynamo, commutation was effected by simply moving the brush, and so moving the section that was to be commutated into a sufficiently strong reversing field: but by the Sayers winding, commutation depended on the *difference* in the E.M.Fs. generated in two reverser bars, in fact, the differential effect was the essence of the whole device. When the commutator was sparkless at no load, and as the load was increased it was found necessary to shift them backwards, it was by no means clear whether this adjustment of the brushes was necessary, because the net reversing E.M.F. was too great or too weak. The armature reaction, as soon as the load was increased, tended to propel the fringe of lines outwards, and if this fringe of lines reached the hindmost reverser bar, and did not reach the leading reverser bar, the differential effect was very great, and far in excess of what was required in order to meet the current, and this mal-adjustment could be

corrected by shifting the brushes backwards. Taking an extreme case, if they were shifted so far back that they came under the pole tip, the reversing E.M.F. would be positively less, yet to the casual observer it would appear the further the brushes were moved backward the greater the reversing E.M.F. It might be argued then that the same non-sparking position could be attained by shifting the brushes forward; but owing to the very rapid way in which the field fell off from the edge of the pole tip, it did not appear to be possible to attain the non-sparking position; hence be believed, for certain strengths of current, it was necessary to shift the brushes back to get a less reversing E.M.F. There was another point in the paper in which the author dealt with the question of the number of segments in the commutators of such machines, and he foreshadowed a very small number of sections, and on that score claimed an advantage in the design of armatures for large dynamos carrying heavy currents. Well, he thought it would be found in practice hardly possible to work with a number of segments much less than, say 30. For large currents, ordinary proportions of the armature gave 60 to 72 bars, and with the usual drum winding this gave a commutator of 30 to 36 sections. Mr. Sayers had illustrated his point by starting with a 48-bar commutator, and then lowering the number to 24, which might be quite possible and practically successful; but in many cases he thought it would be found that the dynamo would start by having 30, or, say, 36 parts, and it would not be possible to reduce these to 15 or 18. The efficiency Mr. Sayers mentioned in his paper sounded high. He did not know whether there was a representative of Messrs. Belliss present that night, but he supposed the efficiency of the engine could be put at about 91 or 91½. But on going into figures, it did not appear that this efficiency was at all unreasonable. The exciting power was given in the paper, and from that they could deduce the loss of watts in the exciting coils as 750, the loss of watts over the resistance of the armature would be, he should suppose, about 1,600, and then they were given a margin of 2,000 watts, which probably divided into 1,000 for hysteresis and friction and 1,000 for eddy currents, and this would leave them with an efficiency of 95 per cent. to obtain 87 per cent. over all. From some experiments which his firm had been carrying out, they had measured the power required to revolve one of those tunnel-wound armatures in the excited field, and so deduced the loss of power with the no load distribution of the field, and from those experiments it appeared that the eddy current loss, whether in the bars or in the pole tips, or in the discs themselves was not very large; but the only doubt arose in the question of how far these determinations could be applied to the full load distribution of lines, as there was no doubt that the lines were massed under the trailing pole tips and under the trailing edge of each of the divisions in the magnet, and there was thus greater loss from the eddy currents and also from hysteresis. In the ordinary continuous current dynamo, if the eddy current loss was measured in the same way, the determination could be applied to the full load case, certainly by increasing it by 25 per cent. at the outside, but it would be interesting if anyone could give any information as to accurate tests on the efficiency at full load. It would require careful experiment, and probably many indicator diagrams, before it could be finally settled.

Northern Society of Electrical Engineers.

Discussion on Mr. Corlett's Paper on Electricity as Applied to Mining.

The Chairman (Mr. Henry Edmunds) said he was sure that all present had followed this paper with great interest. It was a paper which covered a very wide field, and there were several gentlemen there who could discuss it with great ability. There were one or two questions he would like to touch upon, viz.:—1. He would ask why the use of electricity in mining had been limited to continuous currents, and nothing said of transformers? He should think that the employment of transformers would get over most of the difficulties in regard to the loss of voltage in transmission to the bottom of the pit shaft, or along the galleries. 2. He would call attention to the short note at the end of the paper, to the effect that the risk of explosions from gas might be obviated by the use of alternating current apparatus, probably of the tri-phase type. Some three years ago he was at the Frankfort Exhibition, and saw the experiments there in connection with the "Drehstrom" apparatus, exhibited by Prof. Dobrowolsky. He (the chairman) had over in London a motor on this system, in which there were no brushes, which could be started electrically at full load, and which could be reversed and run in either direction. The whole apparatus was perfectly sparkless. It was interesting to note that such a motor had been evolved, so peculiarly suited for mining work, although it was very little known as yet. 3. The incandescent lamp was, of course, the safest illuminant in mines, or wherever there might be an explosive atmosphere. The only difficulties were those arising from switches and fuses and cut-outs which might spark, and thus cause the spark to come into momentary contact with the atmosphere. 4. Mr. Corlett said something about a difficulty arising from the fact that the ordinary incandescent lamp gave no indication of fire-damp. Up to the present no practical device had been invented; but he (the chairman) would like to know what useful purpose would be served by such a device. The ordinary Davey lamp gave warning of the presence of gas, owing to its construction; but surely it was not necessary to fit every miner's lamp with a gas indicator. There were many other pieces of apparatus that indicated the conditions of the atmosphere with greater or less success, and the mining engineer ought not to have any difficulty in learning the state of the mine. As there were several other gentlemen waiting to take part in the discussion, he would not take up any more of their time.

Mr. J. H. Rider: In his remarks, the president mentioned that in alternating currents was possibly found the solution of many of the difficulties met with in pit work. He quite agreed with this, and intended to have spoken on the same matter himself. Mr. Corlett spoke of vulcanised rubber cables as being suitable for use in pit shafts. He (Mr. Rider) remembered a case six or seven years ago with similar cables in a Yorkshire pit, where the cable was eaten right through in a fortnight, with what was found to be some saline solution coming out of the sides of the shaft. A lead covered cable was afterwards used. He inquired if Mr. Corlett had had any similar experience.

Mr. Fawcus said that in giving the figures of the cost of various sized cables, the author had evidently never contemplated the possibility of using lamps of a voltage of from 200 to 250, or he could have halved these costs. Lamps of these high voltages can now be procured commercially; they have been used for some time successfully on the Continent, where the candle-power was not less than 16 in the case of the 200-volt lamps, and 25 in the case of the 250-volt lamps. Mr. Fawcus also agreed with the remarks of Mr. Rider that there was no reason why alternate currents should not be used, at all events for the lighting of coal mines. There was also the alternative of using a pressure of 300 or 400 volts, and running the lamps in series, a system adopted with success in many cases overground.

Mr. C. H. Wordingham expressed surprise that so little reference was made in the paper to sparking, which, in his opinion, was one of the most important obstacles to the introduction of electricity into mines. He suggested that danger might arise from the bare wires used for signalling, by sparking when contact was made, and also by accidental contacts causing unintended signals to be sent. He inquired whether a non-sparking cable, brought out some two or three years ago, had been practically employed. The main cable was stranded over an insulated thin wire coiled within it, the two being connected together at both ends, and fuses proportionate to their sizes being inserted at the surface end. If the main cable broke, the thin wire uncoiled and remained intact, carrying the current until the fuse went at the surface—rupturing the circuit where the spark could do no harm. As regarded the author's suggestion of using 100-volt and a 220-volt machine, he inquired why the surface lamps could not be put two in series as well as those below; the whole of Whitehaven was lighted in this way with most satisfactory results. Another way he might suggest of overcoming the difficulty of the 100-volt drop, would be to put a few cells in series with the lamps at light loads to give a back pressure; these could be usefully employed when charged for bell or detonating work. He asked why the cables were not run down the shaft in an iron pipe instead of in wooden casing. This would be much more suitable, and would prevent their being damaged by saline matter in the way referred to by a previous speaker.

Dr. Keith, after some remarks upon electricity as used in mines in the United States, asked the author if the formula shown, the H due to pipe friction, was in yards or feet. He said that pipe friction was very much increased when there were many turns, bends, or elbows, which proved a very serious matter, adding very much to the head. He would like to know if Mr. Corlett had any formula for calculating this. With reference to small motors in mines, in his own experience he had known motors running which were under 2 H.P., and even as low as ¼ or ½ H.P.

Mr. Geo. J. Somerville gave some particulars about the Earnock Colliery mentioned in the paper. Along with Mr. A. R. Bennett, he was engaged at this installation in the year 1881. The colliery was situated about two miles from Hamilton, in the county of Lanarkshire. The dynamo was a Gramme, and was fixed above ground. It was not driven by a special engine. The leads were taken down the shaft, which was 720 feet deep. The light was supplied by the old style of Swan lamp, and switches were fitted for each set of lights. Double pole mercury switches, specially designed to avoid danger from sparking, were used underground. Portable miners' lamps were also used at the headings, which were about 440 yards from the foot of the shaft.

Mr. Ed. W. Cowan said that he should like to suggest another way of engineering the lighting of the roadway at the bottom of a deep pit shaft in conjunction with the surface lighting. Some other speakers had suggested that an alternating current might be used, and he was about to briefly describe a way of applying an alternating current to this purpose. The alternating current might be obtained from an ordinary continuous current dynamo, such as would be used for the surface lighting, by simply fixing two narrow collecting rings on the commutator, and making electrical connection between them and opposite bars of the commutator. One pair of brushes would then supply continuous current for the surface lighting, and a second pair supply alternating current to the pit shaft. At the top of the shaft a transformer would be fixed, transforming the 70 volts of the alternating current up to, say, 1,000 volts. He would carry the supply to the pit bottom by means of a 7/20 lead covered concentric cable, cleated to the wood-work in the shaft. At the bottom the current would be transformed down again to the pressure required for the lamps. If they compared the cost of this arrangement with that proposed in the paper, they would find that there would be a great saving. He made it out to be £147, against £350 for the same "drop" of 4 per cent., and the same output. It was true that there was some loss of efficiency due to the iron loss in the transformers; in the case taken it would amount to 198 watts, say three 60-watt lamps, but this was not a serious matter where coal was so cheap. There were two exceptions which might be raised, one was the fluctuation in the light due to the low frequency necessarily resulting from using a two-pole machine as generator, but a frequency of 20 or 25 would certainly cause no inconvenience whatever in a mine—it was not very noticeable. The other objection he referred to was the danger to workmen on account of the high pressure; but he thought that by using a concentric cable, and earthing the "outer," there need be no fear on this account. As a further precaution, the

end of the primary composing the layers wound round next to the secondary coils should be connected to the earthed outer. The "inner" would then be practically sealed from end to end. He would be glad to know if Mr. Corlett could see any practical objection to this plan.

Mr. C. M. Dorman wished to suggest that as it was still in most instances desirable to use direct rather than alternating currents for both lighting and power transmission in mines, the financial difficulties attending the use of the abnormally long mains therein used could very often be met by the use of motor transformers. He had never yet seen a multiphase current motor that would respond to the enormous starting torque demanded by underground engineers. He insisted, however, that the important question of the safety of the use of electric currents in fiery mines had been too cursorily dismissed in the paper. The difficulties attending the sparking, which always accompanied the opening of a circuit, had caused considerable anxiety to those responsible for its safe performance. The fire-damp must be absolutely excluded from the box in which the switch was enclosed, otherwise when it became filled with an explosive mixture, the arcing of the switch would cause the lid to be blown off, with consequences perhaps disastrous. The actual presence of fire-damp in the proximity of the switching apparatus was not the only factor to be feared. The possibility—he would not say the probability—existed, that the periodicity of the oscillatory disruptive discharge might be so rapid that the waves radiating from the spark would travel along the ways of the mine, until they found therein some metallic arrangement by which they could produce Hertzian sparks. A very small spark would ignite an explosive mixture. Although he was not prepared to specify the exact necessary conditions, it was at any rate within the realms of uncertainty that short waves started, perhaps, in the switchroom of a central station, might travel along inside the iron pipes containing the mains until they met with the necessary syntonic conditions in, say, a manhole, and there cause one of those mysterious explosions lately so prevalent in our streets. It was a well known fact that not only had the lamp-holders in the Lecture Theatre of the University College, at Liverpool, been short-circuited by waves radiating from a generator emitting electro-magnetic waves of very high frequency, and consequently of very short wave lengths, but that arcs had been struck between the carbons of an arc lamp when they were suitably polarised, but not quite in actual contact. Was there one of them prepared to assert that under favourable conditions the opening of a switch in a circuit fed by an alternating source of ordinary frequency, or even by a direct current, might not set up waves radiating from its oscillating arc of such high frequency as to be capable of exciting any syntonic resonator in the vicinity? One should not be dogmatic on such an obscure question, and the only object of his remarks was to throw out suggestions for future contemplation.

(*Communicated*).—Mr. Dorman would like to add that it seemed he had not made it quite clear to which waves he referred. The wave-length was, of course, equal to the ratio of the speed of propagation to the frequency, consequently the waves thrown out from an alternator whose periodicity was 100 would be 186,660 ÷ 100 = 1,866 miles long. But the electric and magnetic waves do not travel together in phase until a distance from the origin of a quarter of a wave length is reached. Hence the nearest distance from the source at which such action could take place would be 1,866 ÷ 4 = 466 miles, or as far as Inverness from London. Certain parts of the installation might, however, happen to be so arranged as to capacity and self-induction as to cause an oscillatory spark having a periodicity of, perhaps, a thousand million per second, and consequently emit radiation of only a foot wave length. It was to these shorter waves that he had referred in his remarks.

Mr. Baily desired to explain the short circuit that had been produced in the lecture theatre at University College, Liverpool, mentioned by Mr. Dorman. It had been caused by the electro-magnetic waves emitted by an exceptionally large oscillator of Hertz's pattern, acting on a large rectangular surface of some 70 feet circumference, which was formed by the electric light leads and some stay wire. The striking effects produced by these very rapid disturbances of short wave length would be reproduced only in an exceedingly small degree by the comparatively slow disturbances of enormous wave length given out by the ordinary alternating current, and hence there was no fear of a similar catastrophe occurring and producing sparks in a coal mine. He wondered that the dangers of sparks in mines had not been dealt with more fully. An electric spark discharge was one of the favourite ways of exploding mixtures of gases in the laboratory, and one of the points to which most attention was paid by manufacturers of electric mining plant was the elimination of sparking, or the careful shielding of the spark, if its production was unavoidable. He thought that the charge against English engineers of slowness in adopting polyphase current motors was hardly justifiable. Although the efficiency of these motors was fairly good, and some of them would start with a moderate load, no one would claim that they could start with some two or three times the normal load, which was an essential requirement for haulage and traction, and which any good continuous current series motor could easily manage.

Mr. Corlett, in reply, said he began to read his paper with a very lively feeling of failure. Owing to the very short time—about 14 days—available for preparing it, it was, of course, impossible to take in detail one particular branch of the subject, and it was, therefore, considered best to attempt a general sketch of what had been done up to the present in this country. There are very interesting and important mining installations in Europe and America, and at some future date a description of some of them would be instructive and interesting. The president and others suggested for underground lighting the use of alternating current apparatus. In one colliery, Mr. Corlett's firm put down such a plant, working at 2,000 volts, not so much for the sake of reaching underground workings, but for lighting the owner's residence 1½ miles away. It must be remembered, in the first instance, that at a colliery there are at present no skilled electrical engineers. The electric light plant has to be worked by an ordinary engineer of the colliery, and in many cases he is far too busy to devote any personal attention to it. The plant is put down somewhere, and it has to run. In the plant referred to, elaborate measuring instruments were not purchased, and occasional failures occurred on the high-tension wires. For very large plants, which would warrant a thoroughly high-class man being engaged, no doubt such apparatus would give perfect satisfaction, but for small lighting installations at a colliery, trouble and annoyance would probably result. An ordinary plant does not involve more than about 300 lamps of 16 candle-power for any one colliery, and very often only requires 60 to 150 lights. One does not see much of alternators of that size at 1,000 volts. Most alternating tests start at 25 kilowatts, and go up from that; but, as a rule, they do not come down below it. In reply to Mr. Cowan's most practical suggestion, it is rather surprising to hear how cheaply the cost comes out, and this seems a very easy way of doing it. It is often impracticable to run, say, a 220-volt circuit on the surface to include general offices, cabins, &c., where one light is often required. Then all this work has to go more or less under the control of H.M. Inspectors of Mines, an excellent body, whose general feeling is apparently against the introduction into mines of high pressures. It is quite true that in this paper the question of sparking has not been dealt with, first, because the very great proportion of electric transmission work in mines at present has been placed on the main intake: that is, on the main road over which fresh air from the surface is passing to all the workings. As the ventilation of mines has lately been generally improved, so that there is a strong current of fresh air all along these roadways, any gas that might possibly be given off is immediately cleared away. It is at the workings themselves, as the coal is being moved, that bodies of gas are likely to be given off. This is also the reason why the gas indicating apparatus must be attached to the lamps itself. The roadways are narrow; in some mines 3 feet is a wide and high roadway, and 2 feet is not an exceptional one, and the man has to crawl along with the lamp perhaps in in his mouth, and may come into a volume of gas and be suffocated before he will have time to get out, unless his lamp indicates the presence of the gas. The gas indicators must be attached to the large proportion of lamps in collieries. In some cases where a large number of men are working close together under one official, then a lamp without a gas indicator might be used by the men themselves. Mr. Faweus asked why not use 200-volt lamps, to which Mr. Corlett replied that he knew not where to get them of good quality. He had tried (not very recently) lamps up to 130 and 140 volts, which burnt any time from three minutes upwards. If there are lamps of 200 volts, 16 or 32-candle-power, which will have a life of, say, 1,000 hours, and an efficiency of 3 to 4 watts, they can be used about collieries very largely and effect a very considerable saving. Mr. Dorman mentioned the fact that static charges might be given by alternating current, and also made some remarks about Hertzian waves, from which it would appear that there would not be much chance of doing any more mining work; but it is comforting to hear from Prof. Baily that collieries are too small a thing for a wave to take any notice of. At the same time the subject is a very interesting one, and it is hoped that at an early date more information will be laid before this Society. Mr. Clirehugh criticises the suggested standard of 500 volts, considering the severe shock a drawback; but in spite of this, Mr. Corlett thinks a pressure of 500 is useful for every class of mining machinery, except perhaps coal cutting, for which possibly 250—300 might be preferable. Mr. Clirehugh also stated that English engineers had very little idea of what was being done, and instanced a particular installation as a very good job, and was very careful to state that it was done by a foreign firm. It is more than possible that no English manufacturer had a chance of quoting for the necessary plant. Mr. Wordingham spoke about a safety cable, on rather an extensive job in the county of Durham, two or three miles of this cable were laid down; but Mr. Corlett had no definite information about its performance. In reply to Mr. Wordingham's suggestion to use iron pipes for the shaft cable, Mr. Corlett did not think it wise, as it is difficult to get at the cable, and in addition, its whole weight would be on one support at the top, and with a 600-yard shaft, this arrangement would be impracticable. In answer to Dr. Keith the formula gives the head in *feet*. This should have been stated. Mr. Somerville described the Earnock installation, and was careful to state that he used switches on the first job. Mr. Corlett, in conclusion, hoped that his paper had been of interest, and that at an early date some other member would take up one section of mining work and read a paper on the subject.

The Chairman said he hoped members would consider Mr. Corlett's suggestion that detailed papers might be read on some of the topics touched upon that night. He asked the meeting to accord a very hearty vote of thanks to Mr. Corlett for his admirable paper.

SOME MANUFACTURES OF MESSRS. JOEL & CO.

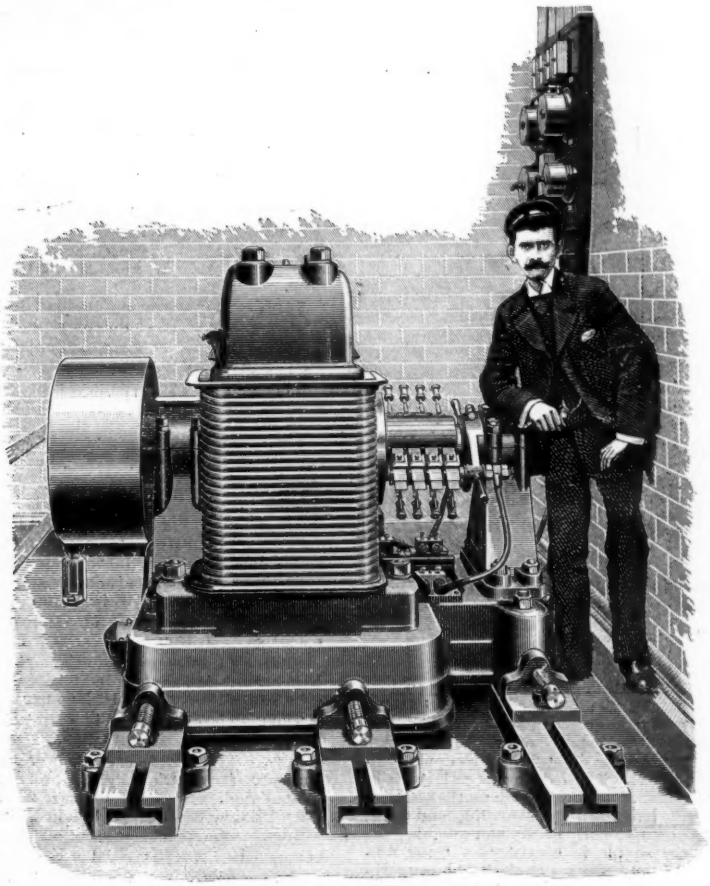
Joel Patent Slow-Speed Dynamos.

The dynamo shown in the illustration is one of the latest examples of the two-pole machines manufactured by Messrs. Henry F. Joel and Co.

The whole machine is very massive weighing about 4 tons, and is mechanically a thoroughly well built machine, and has a very hand-

some appearance, raised on the three iron foundation adjustable slide rails.

The armature in this machine is of the ring type, the iron core being made with stamped thin iron segmental plates made to interlock, and, by means of insulated bolts, held together to central spokes so as to form a complete circular ring core. The whole core is divided into eight segments which are detachable. This construction allows the armature coils to be separately wound on a former, all exactly alike, and then fitted into position. The great advantage of this construction is a certainty of high insulation and ease of manipulation, owing to the parts being of comparatively light weight. There are 80 coils in the armature, each with two turns, or 160 turns in all, the copper of the armature coils is made of twelve strips each $\frac{1}{16}$th × $\frac{1}{16}$ths inch giving a total area of ·375 square inch. The armature is 24 inches in diameter and 18 inches wide overall.



Joel Patent Slow-Speed Dynamo.

The axle is of manganese steel 5 inches diameter, with bearings of gun metal in length 3 times the diameter of the axle.

The commutator is made with sections of drawn copper insulated with mica.

There are four sets of adjustable brushes, and the brush-holders and commutator are quite easily accessible and readily detachable for cleaning, &c. Micanite is used for insulation throughout the armature and fields, with very good results, and gives a high insulation.

The machine is compound wound; the series wire is made of a strand 61/12, and the shunt wire of No. 10 S.W.G.

As the groups of lamps are placed in several buildings at varying distances from the dynamo, the series wire coils were adjusted when the dynamo was running in position, and made to give a slightly rising curve in order to balance the loss allowed in the mains as the load increases. The full load of the dynamo is 550 ampères and 110 volts at a speed of 400 revolutions, and the electrical efficiency at full load is claimed to be 95 per cent. The machine, with two others of the same type, has been running for over two years without the slightest trouble and has given great satisfaction. The load is usually 1,000 16-C.P. lamps, often running all night.

The machine is fitted at Messrs. Adam Lees Cochrane & Bros., Galashiels, where there is an installation of over 1,200 incandescent and 6 arc lamps, and some handsome switchboards made and fitted by Messrs. Henry F. Joel & Co.

Photographic Arc Lamps.

The large reflector lamp shown in our illustration is one of a specially designed type of electric light arc lamps, which during the last 10 years have been taken up and used by the best photographers, often in preference to daylight, for taking photographs.

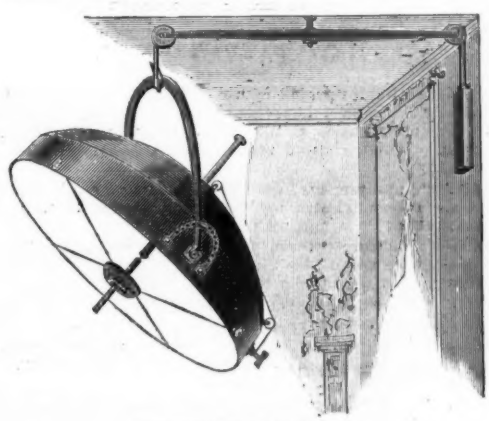
The curve of the reflector and the parallel rim is so designed that the sitter is the focus of the converging rays, and both sides and front of the sitter are illuminated, whilst there is sufficient divergence of the light to give a luminous atmospheric effect outside the sitter. By this reflector soft and true photographs are taken, and with a skilled artist effects of singular beauty are often obtained.

The light given is of 20,000 to 50,000 candle-power at 60 to 80 volts, with a current of 60 to 80 ampères.

The carbons used are 22 mm. for the positive and 18 mm. for the negative. The direct rays of this powerful light are screened from the sitter by the secondary reflector placed under the arc. The reflector is balanced and can be adjusted in any position, and has a locking arrangement to secure it as desired.

With this lamp a photograph can be taken in one and a-half seconds, using quick plates, and prints can be copied in from 15 to 30 minutes.

The lamp shown in the illustration is made to hand feed the carbons with an endless screw action, and it is effective and reliable. Messrs. Joel & Co. also make a self-feeding automatic lamp, using the Pilsen core and coils, and this lamp will burn continuously for some six hours, with a steady arc, and in either a horizontal or vertical



Photographic Arc Lamp.

or any intermediary position or angle. This special advantage is peculiar to the Pilsen lamp principle. Other types of lamps with clockwork clamps or gear of any sort would obviously not work

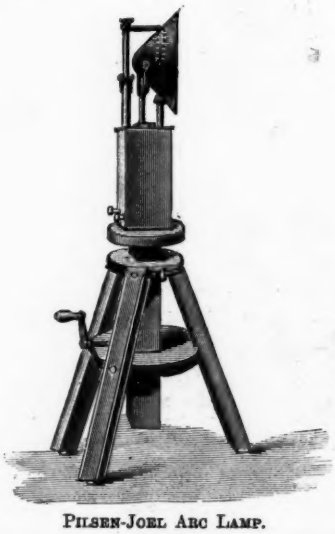
in a horizontal position, and it is this special feature that has induced Messrs. Joel & Co. to give special study and attention to the adaption of the lamp for photographers.

The large reflector lamp is used for either continuous currents or alternating currents; for use with alternating currents a special winding of the coils and construction of the core is necessary. The core in this case is made of finely divided and insulated iron, with narrow bands of copper adjusted in position on the core, which act as short-circuiting coils round the core and prevent the iron conical cores as they move in the coils from choking back the current in the coils, whilst the magnetic pull is not diminished, and thus allows the core and coils to act one upon the other in a similar way to continuous currents.

Messrs. Joel & Co. have recently supplied their lamps for use at the following theatres: Lyric, Haymarket, Gaiety, Daly's, and for the fancy dress balls at Covent Garden, as well as many of the leading photographers.

Pilsen-Joel Arc Lamp.

The arc lamp shown in the illustration is one of the well-known Pilsen type of lamps.



Pilsen-Joel Arc Lamp.

The lamp is one of the P 13 type—a stand lamp—and is fitted on the adjustable camera stand, and designed and used in many installation for printing photographs and reproducing photo-engravings, and such work, and gives an effective 6,000 candle-power. Fitted with a parabolic, or other curved reflector, the light is reflected with increased power on any special object. The reflector is adjustable in any direction, and the lamp with reflector only, without the stand, is useful as a search lamp or cargo lamp, and for signalling and other useful purposes. The light is exceptionally steady and reliable; the lamp is, as is well known, very simple in construction, being self-regulating by the electric current only, and has no clockwork or tooth-wheel gearing, and is easily manipulated and kept in working order by any intelligent workman.

It is a very useful type of lamp for photographers. The lamp takes 50 volts and 25 ampères, and is made to work either with continuous or alternating currents.

NEW PATENTS—1895.

22,965A. "Improvements in the method of and apparatus for electrically heating metal or other conducting bodies. W. P. Thompson. (Communicated by C. L. Coffin, United States.) Dated February 20th. [Dated claimed under rule 19, November 27th, 1894.] (*Complete.*)

3,458. "Improvements in and connected with arc lamps." J. B. Ranton. (Communicated by W. Jandus, United States.) Dated February 18th.

3,505. "Improvements in governors or speed regulators for engines, turbines, and the like; suitable also for sluices." J. S. Raworth. Dated February 18th.

3,506. "Improvements in steam turbines." J. S. Raworth Dated February 18th.

3,511. "An improved method of electrically signalling upon railways." J. W. Courtis, F. P. Sibley, and C. Dallimore. Dated February 18th.

3,512. "An apparatus for electrically communicating from a fire engine to a fireman in charge of hose on building." J. W. Courtis, F. P. Sibley, and C. Dallimore. Dated February 18th.

3,531. "Improved telegraphic type-writer." L. Kamm. Dated February 19th.

3,548. "Improved electric switch." W. Edge. Dated February 19th.

3,573. "Improvements in telephonic apparatus." N. L. Burchell. Dated February 19th. (*Complete.*)

3,582. "Improvements in casings for electricity conductors." H. Reason. Dated February 19th.

3,593. "Improved wire draw vice and key, particularly intended for use in telegraph and telephone wire line work." W. B. Shaw. Dated February 19th.

3,605. "Improvements in or relating to devices applicable for electrically lighting pipes, cigars, cigarettes, or the like." O. Stuart, and T. H. Aschcroft. Dated February 19th.

3,622. "Improvements in electric dental engines." W. E. Wheeler. Dated February 19th.

3,625. "An improved process for coating or plating metals with aluminium or aluminium alloys by electrolysis." C Oppermann and E. Bailey. Dated February 19th.

3,633. "Improvements in or connected with the distribution of electricity." T. Parker, J. H. Woodward, and E. S. G. Rees. Dated February 20th.

3,662. "Improvements in electrical contacts for torpedoes." J. R. Scott. Dated February 20th.

3,679. "Improvements in the construction of electric arc lamps." T. S. Foster. Dated February 20th.

3,685. "Improvements in the insulation of electric conductors." H. Edmunds. Dated February 20th.

3,687. "Improvements in or relating to electric traction." W. S. Boult and C. R. Boult. Dated February 20th.

3,693. "New and improved electric lock and system of electric locking for the purpose of securing additional safety in railway signalling." J. F. W. Morris and G. Mumford. Dated February 20th.

3,701. "Improvements in electrical driving gear for vehicles." W. C. Bersey. Dated February 20th.

3,763. "Improved means and appliances for submarine signalling." M. T. Neale and A. Smith. Dated February 21st.

3,770. "Improvements in or connected with the filaments of incandescent electric lamps." J. Graham and H. Chapman. Dated February 21st.

3,779. "Improvements in economising apparatus for the carbons of electric arc lamps." A. Albrecht. Dated February 21st. (*Complete.*)

3,788. "Improvements in electric locomotives chiefly designed for use in mines." B Lebrun. Dated February 21st.

3,809. "Improvements in electric and galvanic batteries and accumulators." J. B. Torres. Dated February 22nd.

3,812. "Improvements in electrical switches or circuit closers." M. H Goldstone, and J. H. Ward. Dated February 22nd.

3,821. "A new form of alternating current dynamo-electric generator." J. Finlayson. Dated February 22nd.

3,841. "Improvements in the method of and apparatus for ventilating manholes, electric light boxes, and underground chambers or cellars of all sorts." G. H. Nisbett. Dated February 22nd.

3,863. "Improvements in or relating to apparatus for checking runaway horses." P. Arriaban. Dated February 22nd. (*Complete.*)

3,864. "Improvements in power gearing and current controlling apparatus for electric cars." E. A. Sperry. Dated February 22nd. [Dated applied for under Patents, &c., Act, 1883, Sec. 103, July 24th, 1894, being date of application in United States.] (*Complete.*)

3,866. "Improvements in electrical switches." R. W. H. Newington, and R. Hewlett. Dated February 22nd.

3,874. "Improvements in adjustable electric lights." A. L. Fyfe. Dated February 22nd.

3,903. "An improvement in electrical conductors." H. D. Fitzpatrick. (Communicated by the Electric Bell and Resistance Company, United States.) Dated February 23rd. (*Complete.*)

3,954. "Improvements in and relating to telephone systems." S. Berditschewsky (called Apostoloff), and M. Freudenberg. Dated February 23rd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

7,875. "A galvanic chain for curative purposes." Mrs. F. Fritsche. Dated April 20th. Claim:—A chain adapted to act as a voltaic cell, mainly consisting of zinc and copper chains with rounded links, connected to each other alternately, or in rotation, by cords made of material capable of readily absorbing perspiration, for the purpose of generating a slight but uniform electrical current.

13,405. "Improvements in and relating to induction coils for medical purposes." A. Cheetham and F. Brown. Dated July 11th. Consists in the arrangement whereby the two ends of the core are extended and brought together so that both poles are presented to the contact breaker. 3 claims.

16,425. "Improvements in electric accumulators or storage batteries." D. Young. (Communicated from abroad by the Hess Storage Battery Company, of America.) Dated August 28th. Consists, essentially, in electrodes arranged within a cell and having their active surfaces separated by a layer of quartz sand, or other suitable non-electric conducting material composed of separate grains or particles held together by non-electric conducting adhesive material. 4 claims.